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—Vol. 20

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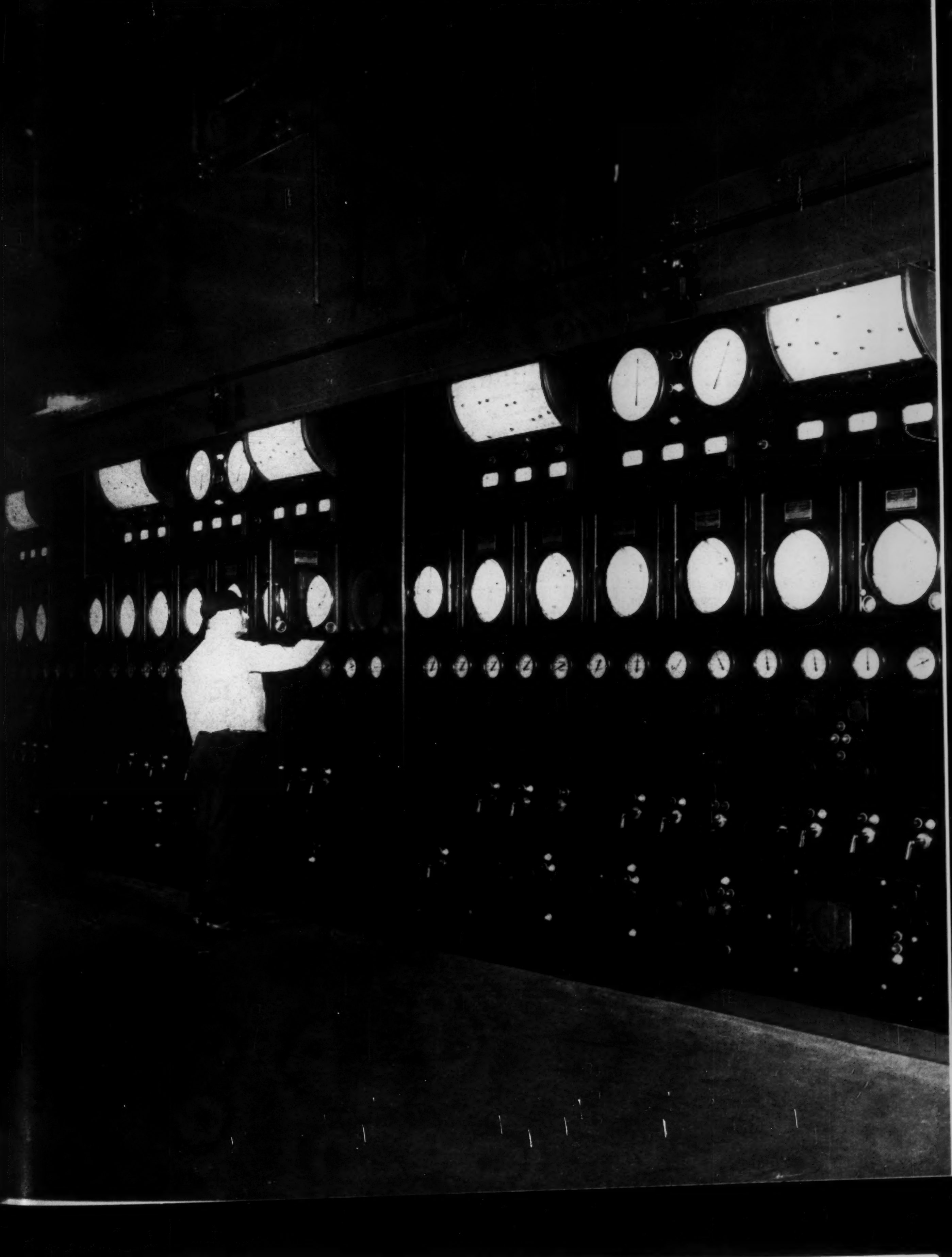
Instruments

IE MAGAZINE of MEASUREMENT and CONTROL

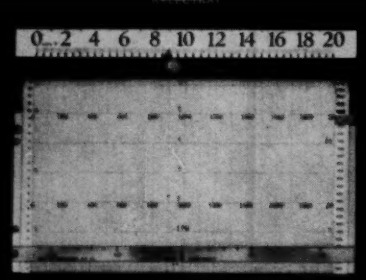


"Speed is Important"

Speed is perhaps the greatest single factor in winning baseball. Star pitchers like Johnson . . . Matthewson . . . Alexander . . . are remembered by all baseball lovers chiefly because of their blinding speed—which paid off in wins time after time.

TAG CELECTRAY Pyrometers are FAST and ACCURATE

In batch or continuous heat treating processes, TAG CELECTRAY Recording Pyrometers have the speed and controlled balance necessary for writing fast, extremely accurate temperature records. That's because these instruments operate photoelectrically, utilizing an inertialess beam of light, a mirror galvanometer and a phototube. This means more processing efficiency and economy for you!



C. J. TAGliabue Mfg. Co.

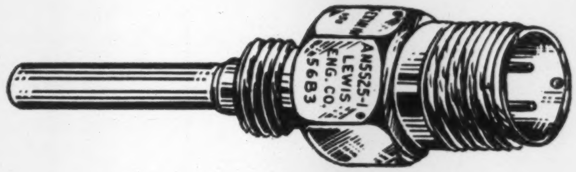
549 Park Avenue Brooklyn 5, N. Y.

Representatives in Principal Cities

Always Specify TAG

SUBSIDIARY OF PORTABLE PRODUCTS CORP.

—THE LEWIS RESISTANCE BULB—



MODEL 56B3
(AN5525-1)

THE LEWIS RESISTANCE BULB MEETS EXACTING SPECIFICATIONS

RESPONSE TIME — Averages 5 seconds from 100°C to 10°C when taken from boiling water to an ice bath.

HERMETICALLY SEALED — Silver Soldered Assembly, by means of modern induction heating methods. The Terminal Pins are sealed in glass to the metal cap as in electronic tubes.

HIGH TEMPERATURE OPERATION — Built to withstand a test temperature of 300°C for one minute. Bulbs model 56B5C and 56B6 will withstand operating temperatures of 500°F for a minimum of 500 hours. Model 56B6D will withstand 300°C for a minimum of 8 hours.

TOUGH — Built to "take it" of Stainless Steel. The stem is of 18-8 type 304 (AMS5560A) and the head is constructed of Type 303 (AMS5640B). Polarizing Pin is of unique construction to prevent bending, twisting, or becoming loose.

STANDARDIZED RESISTANCE Vs. TEMPERATURE — The resistance - Temperature characteristics meet "AN" specifications from —70°C to +200°C, and have been extended to 300°C.

ACCEPTED AS STANDARD BY LEADING AIRFRAME MANUFACTURERS —

These Bulbs are used as standard equipment on the following Aircraft:—

BOEING STRATOCRUISER 377
CONSOLIDATED 240
DOUGLAS DC-6
LOCKHEED CONSTELLATION 49
MARTIN 202 and 303
REPUBLIC RAINBOW RC-2

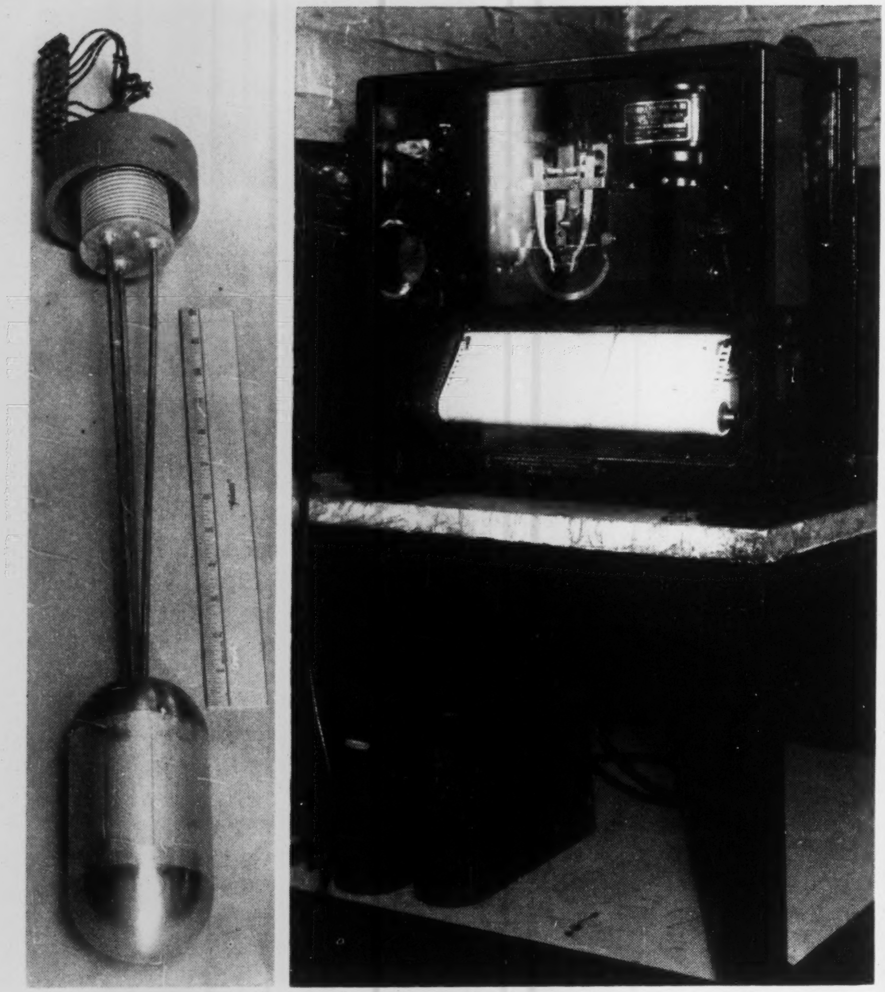
THE LEWIS ENGINEERING CO.

Specialists in Engine Temperature Measurements

• NAUGATUCK, CONNECTICUT. •

POTENTIOMETERS • • • • • • SELECTOR SWITCHES • • • • • • • • • THERMOCOUPLES •
PYROMETERS • • • • • • RESISTANCE THERMOMETERS • • • PROTECTION TUBES •

INSTRUMENTS ON THE MARCH



(Left) Primary element of new flowmeter. The deflection-measuring electric gage is housed in the metal bellows. *(Right)* The recorder and integrator.

Vane-type Flowmeter with Electrical Transmission

NEW YORK CITY. — Engineers of Consolidated Edison Co. have devised a new form of the "vane" or "force" type flow-rate meter for use in studying flow conditions in that combination company's gas mains. Although still in the experimental stage, the device is expected to do away with installation difficulties common in other types of gas flowmeters. As worked out by Consolidated Edison's Test Bureau, the new meter may be inserted in a gas main through a tapped hole. Other meters require that the gas main be cut through unless provision was made at the time the main was put in.

The new flowmeter employs Baldwin-Southwark electrical strain-gage wires 0.001″ in diameter which change their resistance to an electrical current as they are extended or compressed. Four such strain gages are mounted in a Wheatstone bridge circuit on a 3″ piece of spring steel. The upper end of the steel strip is firmly anchored to the gas main while the other end supports a steel tripod extending into the gas stream. At the end of the extension is a hollow aluminum cylinder closed at either end with a hemispherical cap. This vane is suspended at the center of the gas main.

When gas flow in the main changes, the degree of deflection of the hollow cylinder changes. As the assembly, with the exception of the spring steel, is rigid, the entire motion is transferred to the spring to which the strain gages are attached.

The electrical changes result in a flow of current through a sensitive galvanometer which causes it to deflect. This, in turn, automatically controls a slide wire resistor which restores balance to the galvanometer. A pen mechanically attached to the slide wire indicates the change graphically on a moving chart. The strain produced in the gages is proportional to pressure on the aluminum cylinder and this pressure is proportional to the square of the velocity of the gas stream. A compensating balancing circuit is incorporated in the recorder so that it shows a linear response to velocity changes.

The static-pressure compensation is automatic: a variable shunt resistance incorporated in the measuring circuit of the recorder is operated by a 100″ (H_2O) pressure gage to vary the recorder constant with changes in the static pressure.

Variations in temperature from 50°F. to 70°F. introduce errors less than 1 percent. Since the gas temperature does not deviate beyond these values, temperature correction is neglected.

The integrator was designed for use with a standard type recorder. The integrator register is friction-driven by a metal disk which rotates at 1 rpm. The register is mounted on a carriage which is mechanically attached to the recorder pen-arm. Changes in gas flow change the position of the pen-arm and register carriage simultaneously, thereby changing the contact point of the friction-driven rotor of the register on the rotating metal disk. As the gas flow increases the radius of the register driving contact on the rotating disk increases, thus increasing the rate of registration.

Cavity Magnetrons Find Peace-time Uses

NEW YORK CITY. — The mighty cavity magnetron — the electron tube that gave American radar its powerful wallop — leads the Western Electric

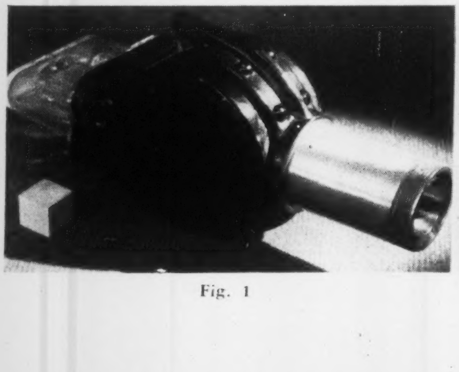


Fig. 1

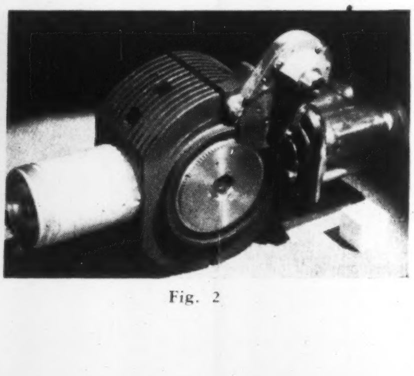
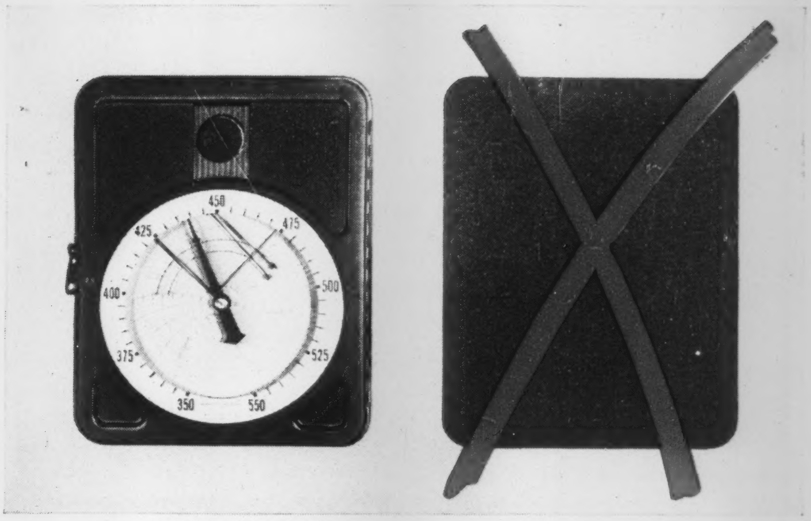


Fig. 2

Save Panel Space with



You can cut control panel space easily by using the Bailey Pyrotron Temperature Controller. This Potentiometer-Pyrometer can be furnished to record and control two separate temperatures at the same time.

Two Controlling Pyrometers in One Instrument

Other Unusual Features of Bailey Pyrotron Dual-Temp Controllers

1. Null-balance measuring systems kept in continuous balance by inertia free electronic detectors and motor control systems.
2. Ample power for operation of control and alarm devices provided by reversible slidewire drive motors.
3. Usual Galvanometer replaced by sturdy electronic units.
4. Conversion of thermocouple emf to a-c by saturable core reactors containing no moving parts.
5. Maintenance simplified by easy accessibility and by interchangeable packaged units.
6. Careful leveling or protection against usual vibration not necessary.

● Each control system is actuated by a thermocouple which is always connected to the self-balancing potentiometer circuit. *Each temperature has its own independent system.*

A comparison of related temperatures can be made quickly as both records are on the same chart.

For details on this unusual thermocouple type Recording Controller ask for Bulletin 232.

P-12

BAILEY METER COMPANY
1041 IVANHOE ROAD • • • CLEVELAND 10, OHIO
Controls for Processing

TEMPERATURE
PRESSURE
% OXYGEN
% COMBUSTIBLES

FLOW
LEVEL
DENSITY
RATIO

vacuum-tube display at current expositions. During the war Bell Telephone Laboratories which designed over fifty different types and Western Electric which manufactured thousands of tubes from these designs became the foremost industrial team in the magnetron field.

Consisting of a cylindrical unipotential-heater cathode surrounded by a massive copper anode, the cavity magnetron falls into a two-element classification. Each anode contains a number of resonant cavities shaped in cross-section like keyholes with the thin slots of each feeding into the central chamber. The cavities—in effect resonant circuits—become excited as electrons emitted by the cathode are whirled in the cathode chamber past the slots by the action of an axial magnetic field.

Among the magnetrons shown is the famous 706AY-EY in the S-band (Fig. 1), essentially an improved version of the original magnetron secretly brought to the United States by the British in 1940. In a matter of less than five weeks, Bell Labs had completely tested the tube and constructed five duplicates. One of the *tunable* cavity magnetrons on display is the 5J26 (Fig. 2) designed by Bell Labs to act as replacement for the 4J21 to -30 fixed-frequency series, with which it is mechanically as well as electrically interchangeable. Fig. 3 shows the 714AY designed by Bell Labs to operate in the 3280-3320-Mc. range in the S-band. At the left in Fig. 4, between the magnet poles, is the 720AY-EY S-band fixed-cavity magnetron; at the right the 725A which is unique in that it was the first tube on which the scaling theory was tested in going from S- to X-bands and served as prototype for subsequent X-band work.

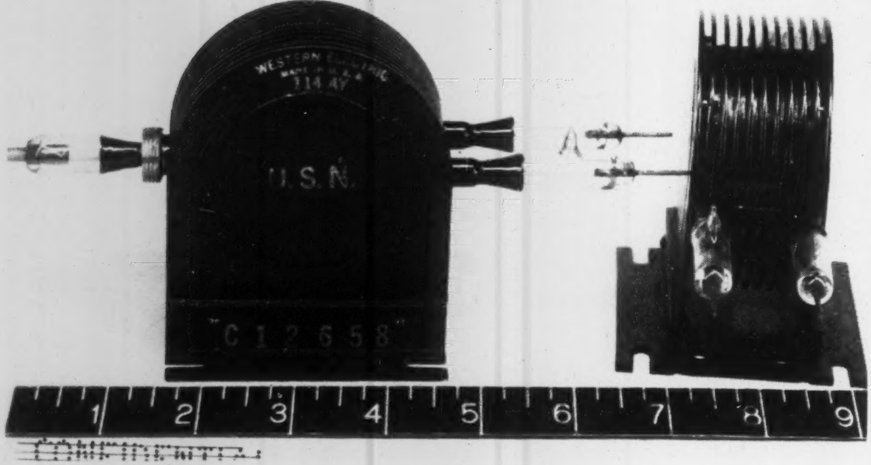


Fig. 3

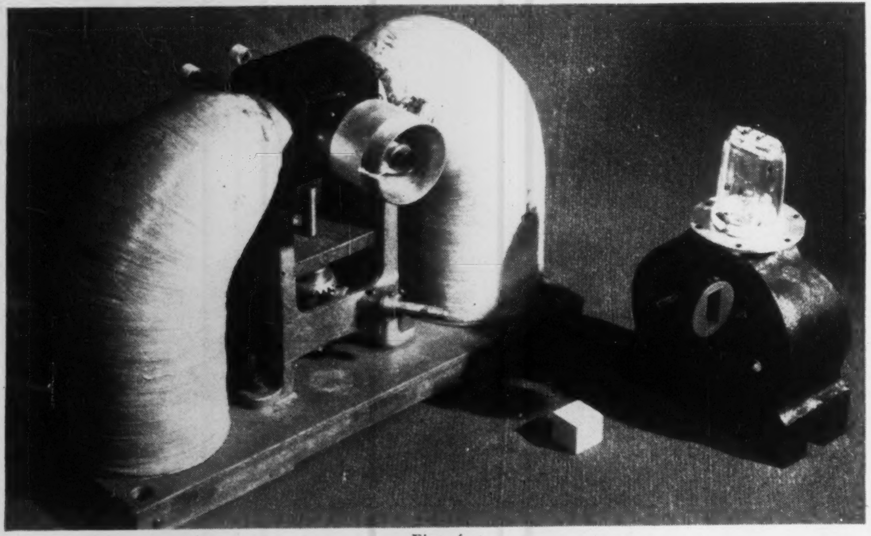


Fig. 4

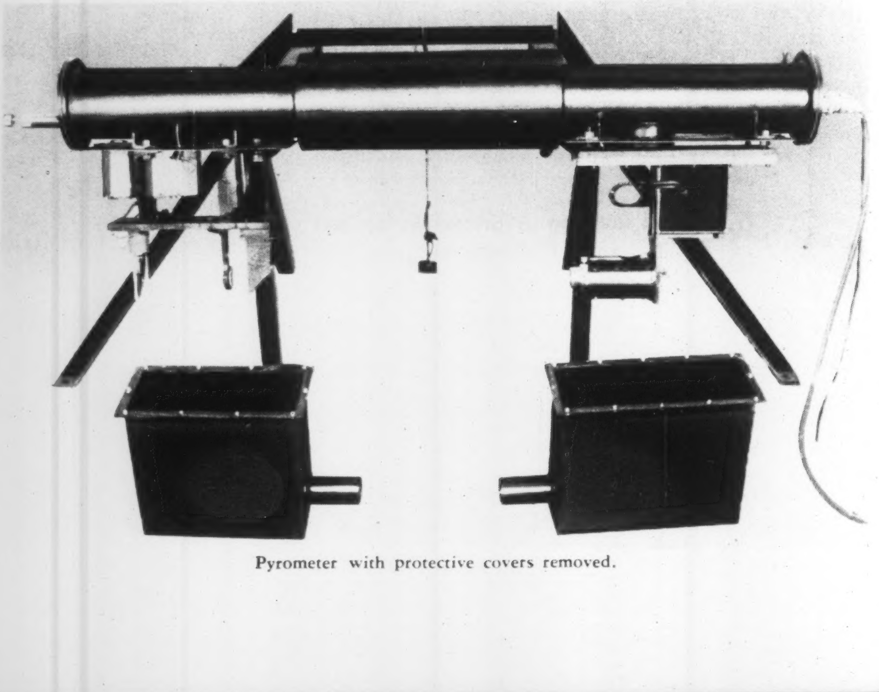
The Absorption-emission Pyrometer: a New Method for Measuring Flame Temperatures

CINCINNATI, Ohio.—Rocket exhaust flames believed to reach temperatures of as much as 4,000°F. can be measured by a new device described here on Oct. 25 at the Thirty-second Annual Meeting of the Optical Society of America, by Donald H. Jacobs, Supervisor of the Long Range Navigation Section of the Aerophysics Laboratory of North American Aviation, Inc.

The problem of measuring the temperature of the exhaust flame of a rocket has proved baffling to engineers for a number of years. Thermocouples are destroyed by the terrific heat. A few measurements have been made by the sodium line reversal method but this offers many serious disadvantages. It requires the addition of special materials to the rocket fuel and only works if the rocket exhaust temperature remains constant for an appreciable period of time. It requires an observer to remain near the motor being measured—an undesirable situation because these motors are likely to blow up.

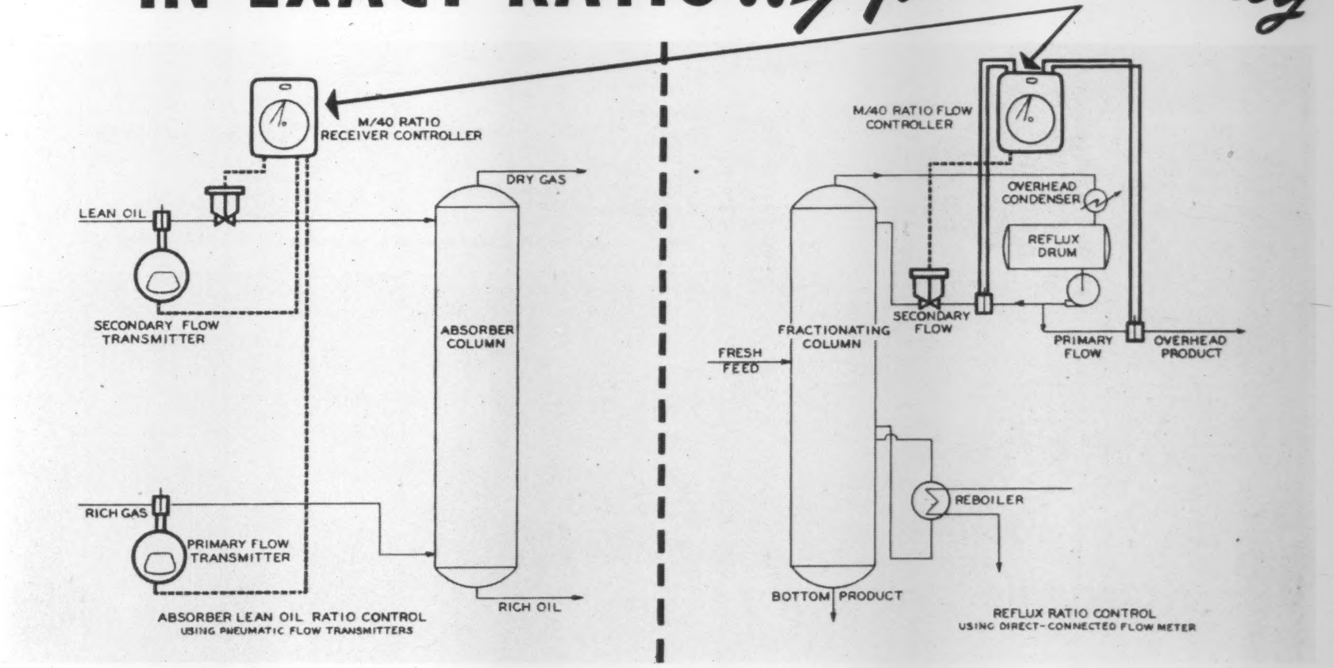
The completely new type of instrument disclosed by Jacobs has been named by him the Absorption-emission Pyrometer.

A light source in the instrument sends a beam of light through the exhaust flame of the rocket and another beam of light from the same source is by-passed around the flame by a series of mirrors. A system of mechanical shutters causes these two beams of light to fall alternately upon a photocell;



Pyrometer with protective covers removed.

KEEPING FLOW OF TWO FLUIDS IN EXACT RATIO..*Automatically*


M/40 RATIO RECEIVER CONTROLLER
DRY GAS
LEAN OIL
SECONDARY FLOW TRANSMITTER
ABSORBER COLUMN
RICH GAS
PRIMARY FLOW TRANSMITTER
RICH OIL
ABSORBER LEAN OIL RATIO CONTROL
USING PNEUMATIC FLOW TRANSMITTERS
M/40 RATIO FLOW CONTROLLER
OVERHEAD CONDENSER
REFLUX DRUM
SECONDARY FLOW
FRACTIONATING COLUMN
FRESH FEED
PRIMARY FLOW
OVERHEAD PRODUCT
REBOILER
BOTTOM PRODUCT
REFLUX RATIO CONTROL
USING DIRECT-CONNECTED FLOW METER

with FOXBORO Flow-Ratio Controllers on the job

REG. U. S. PAT. OFF.

● By controlling the flow of a liquid or gas in unvarying, continuous ratio to that of another, sensitive processes like distillation and absorption can be streamlined to peak efficiency. Every change in the flow of the primary fluid is reflected by a proportional change in the secondary fluid flow, thereby maintaining a constant ratio between the two. The operation is precise, instantaneous, and completely automatic. Liquid level, pressure, and other process variables may similarly be ratio-controlled. (Controllers are also available to ratio more than one secondary flow to a common primary flow.)

The Foxboro Flow-Ratio Controller offers unique advantages both in its measuring system and in its M-40 control mechanism. Its combination of accuracy, sensitivity, flexibility, and simplicity is unrivalled.

The ratio mechanism has been specifically designed to maintain set ratios accurately through the whole range of the instrument. The desired ratio is easily obtained by turning a calibrated thumb wheel visible through the chart plate. The mechanism is a compact, rugged unit that fits into any Model 40 Controller.

Write for detailed information. **The Foxboro Company, 46 Neponset Ave., Foxboro, Mass., U.S.A.**

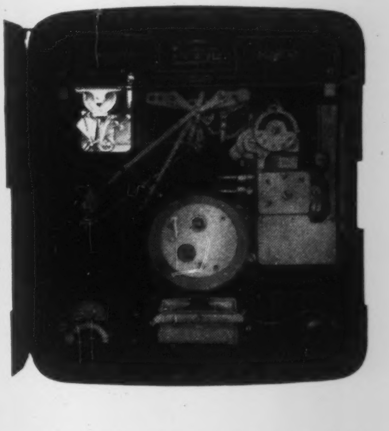
FOXBORO
REG. U. S. PAT. OFF.

M-40

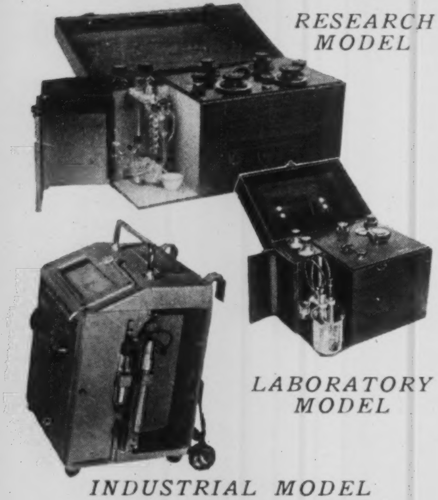
CONTROLLER

THE ONLY CONTROLLER WITH *Permaligned* CONSTRUCTION

Foxboro Flow-Ratio Unit installed in M-40 Controller



CAMBRIDGE



pH METERS

Line-operated—accurate!

The three models illustrated above incorporate many important advantages. All are line-operated from any 110-volt A.C. outlet . . . can be kept turned on continuously to make pH measurements at any time without delays of waiting through warm-up periods. Ruggedly built, portable, they are simple and convenient to use.

Research and Laboratory Models use an electron-ray tube for precise null-point indication . . . sensitive and cannot be injured by mismanipulation.

Industrial Model reads directly in pH values on 0 to 14 pH scale. Specially designed for all-around plant use.

RESEARCH MODEL: Accuracy .02 pH. Range 0 to 14 pH; 0 to 1200 millivolts. Size, 8½" x 10" x 17½"; weight 25 lbs.

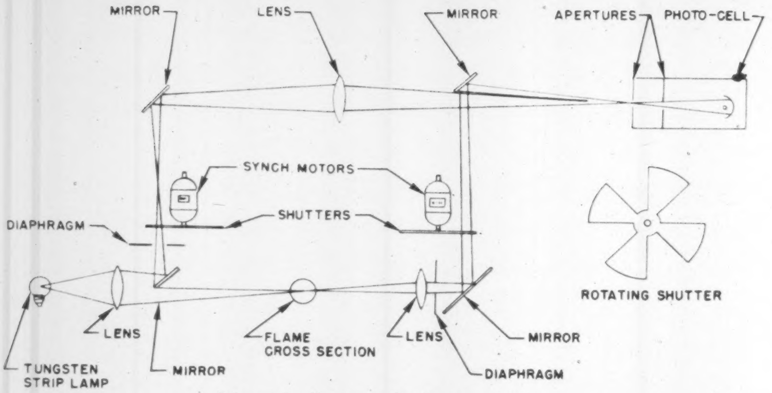
LABORATORY MODEL: Accuracy 0.5 pH. Range 0 to 14 pH; 0 to 1000 millivolts. Size, 12¾" x 10½" x 8¾"; weight 17 lbs.

INDUSTRIAL MODEL: Accuracy .10 pH. Range 0 to 14 pH. Size 7" x 8½" x 11¼"; weight 10 lbs.

OTHER pH EQUIPMENT: Other line-operated Cambridge pH Equipment includes single- and multi-point Indicators and Recorders.

Write for Bulletin 910-MR

CAMBRIDGE
INSTRUMENT COMPANY INC.
3742 Grand Central Terminal
New York 17, N. Y.
Pioneer Manufacturers of
PRECISION INSTRUMENTS



Schematic diagram of new pyrometer.

Complete working set-up of pyrometer, including electronic components in rack, and recording oscillograph on table at right. The temperature of an acetylene torch flame is being measured.

this photocell is connected to various monitoring, amplifying, and recording circuits. Studies of the theory of this device show that if the brightness of the light source is varied so that the photocell always receives the same amount of light from the beam that passes through the flame and the beam that passes around it, the temperature of the rocket exhaust will bear a known relation to the temperature of the light source.

With this instrument it is possible to record automatically and continuously the fluctuations in the temperature of a rocket motor as the motor starts up and runs under various experimental conditions. Provision is included in the instrument for means of making a survey of the change in temperature across various cross-sections of the exhaust. It is not necessary that an instrument operator be in the vicinity of the rocket when it is running.

Five Million Pictures per Second

CINCINNATI, Ohio.—A new motion-picture camera which will take more than five million pictures a second was described here on Oct. 25 at the Thirty-second Annual Meeting of the Optical Society of America, by Dr. Brian O'Brien, Director of the Rochester Institute of Optics at the University of Rochester.

When the motion-picture of a rifle bullet, taken by the new technique, is projected on a screen at the usual speed, it requires a minute to show one inch of the bullet's movement. The camera is ten times as fast as any previously made. Gordon G. Milne, research associate in optics at the Institute, worked with Dr. O'Brien in its development. The following is a summary of the disclosure by Dr. O'Brien and Mr. Milne:

Exposure by conventional means at speeds of several million frames per second would require a film movement through the camera at twenty to fifty times bullet velocities. If, instead, the film is stationary and the image caused to move by means of moving optical parts such as rotating mirrors, the total number of frames and thus the total duration of the motion picture becomes

TOP OF FLOAT
CENTER OF FLOAT
BOTTOM OF FLOAT
FISHER
LEVEL-TROL

The measurement "heart" of the Fisher Level-Trol—the renewable torque tube element and float rod assembly.

Announcing

FISHER'S

RENEWABLE INTERCHANGEABLE TORQUE TUBE

NOW STANDARD CONSTRUCTION IN ALL LEVEL-TROLS

The renewable, interchangeable torque tube feature of the Type 249 makes it possible for the operator to exchange or replace the torque tube in a Fisher Level-Trol without dismantling the entire level controller or breaking into pressure piping. All Fisher Level-Trols are now furnished with this improved feature. For full details write for Bulletin F249. Fisher Governor Company, Marshalltown, Iowa.

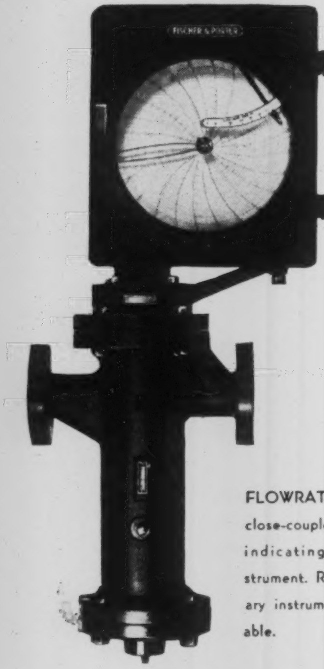
FISHER *Level-Trol*

Mr. Instrument Engineer:

Have you been overlooking a good bet in respect to

PROCESS STEAM METERING

The numerous advantages of the FLOWRATOR meter (formerly called Rotameter) are as valuable for steam measurement as for flow rate measurement of chemicals.



FLOWRATOR meter with close-coupled secondary indicating-recording instrument. Remote secondary instruments are available.

You will find the steam FLOWRATOR instrument competitive in price from ¼" up through 4" size and you will be able to measure the low night flows or end-of-cycle flows accurately. Right down at 5% on the scale readings will be just as valid as at high flows—no square root scale distribution. Furthermore, you won't have to look for a straight run of pipe, or worry about straightening vanes or about condensate pots, overload protection, high pressure loss at high flows.

The F & P "Armored" FLOWRATOR instrument is suitable for complete jacketing with insulation, is available for all industrial operating pressures and temperatures. Its precise integrator will give you a reliable steam use totalization under load fluctuations and low end of scale flows which play havoc with orifice meter accuracy.

Send for Catalog 40 for complete details of "Armored" FLOWRATOR instruments.

FISCHER & PORTER CO.
DEPT. 7Y-5C HATBORO, PA.

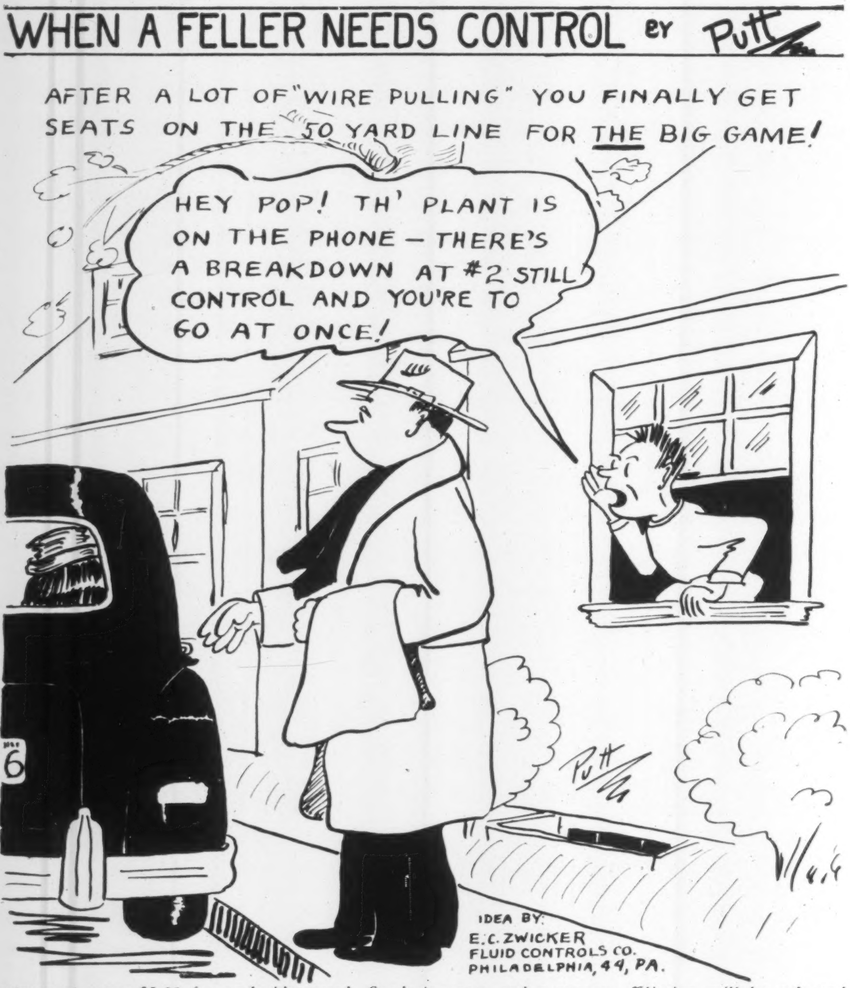
FLOWRATOR
TRADEMARK

quite limited. Moreover, rotating mirrors or their equivalent usually make it difficult to secure sufficient illumination on the film for high speeds.

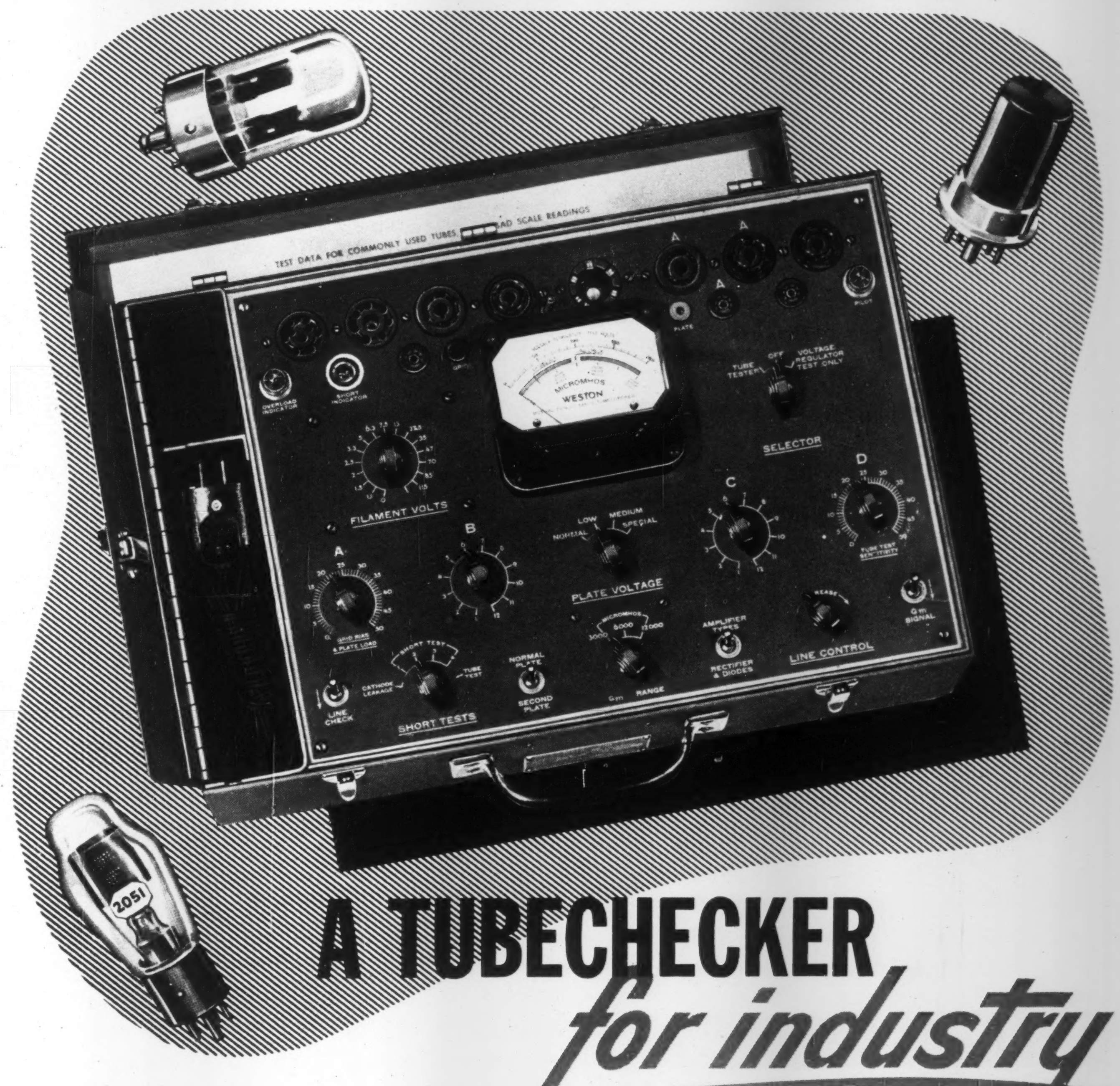
These difficulties are avoided if the image of the rectangular picture is broken up into a series of very narrow strips which are then reassembled, end to end, into one long narrow strip. In the new camera this image dissection is accomplished by a stationary optical system of somewhat unusual properties, and the single long and narrow strip made up of the dissected elements of the original picture is imaged on the negative film as a line so narrow that it is less than the resolving power of the film itself. The film is driven past this line image, and in a direction perpendicular to the line, at the comparatively high speed of 400 fps. This is accomplished by containing the film on the inside of a shallow rotating drum where it is held in position by centrifugal force 16,000 times gravity.

The narrow-strip image is drawn out by the moving film into a streak, and the variations in photographic negative density at any place across this streak contain all the elements of a complete rectangular picture for the particular instant of time represented by the position selected along the streak. The negative film need move by only the width of the narrow slit image to produce a complete new frame of th original rectangular event or pictur Since the camera is shutterless, th motion of the film produces a blurrin of the image, but this blurring is limite to the slit width: no more than th resolving power of the negative film itself.

After processing, the negative mus be reconstructed into the original rectangular picture by projection bac through an optical system similar t that which formed it. This is done b an automatic projection printer which produces an ordinary 16-mm. m-p. print which can be run through an ordinary projector. In the present camera the negative is enlarged ten-fold in printing back to a 16-mm. m-p. frame. Thus the film grain imposes a serious limitation on picture quality although the resolving power secured is adequate for the study of many subjects. The nominal rating of the present camera is five million frames per second, but the behavior is still satisfactory at higher speeds. The exposure time is approximately one seven-millionth of a second but, because of the peculiar arrangements of optical system and film, the interval between frames can be less than the exposure time while still preserving the continuity of the picture.


WHEN A FELLER NEEDS CONTROL BY Putt
AFTER A LOT OF "WIRE PULLING" YOU FINALLY GET SEATS ON THE 50 YARD LINE FOR THE BIG GAME!
HEY POP! TH' PLANT IS ON THE PHONE — THERE'S A BREAKDOWN AT #2 STILL CONTROL AND YOU'RE TO GO AT ONCE!
Putt
IDEA BY: E.C. ZWICKER FLUID CONTROLS CO. PHILADELPHIA, 44, PA.

Instruments pays $5.00 for each idea used. Sender's name and company affiliation will be acknowledged in the cartoon unless we are specifically requested not to do so.
Address Cartoon Dep't, *Instruments*, 1125 Wolfendale St., Pittsburgh 12, Pa.


TEST DATA FOR COMMONLY USED TUBES
OVERLOAD INDICATOR
SHORT INDICATOR
MICROMHOS
WESTON
TUBE TESTER
OFF
VOLTAGE REGULATOR TEST ONLY
SELECTOR
FILAMENT VOLTS
A
B
C
D
LOW
MEDIUM
NORMAL
SPECIAL
PLATE VOLTAGE
GRID BIAS & PLATE LOAD
MICROMHOS
3000
6000
12000
Gm RANGE
AMPLIFIER TYPES
RECTIFIER & DIODES
LINE CONTROL
Gm SIGNAL
SHORT TEST
CATHODE LEAKAGE
TUBE TEST
SHORT TESTS
NORMAL PLATE
SECOND PLATE
LINE CHECK
PILOT
PLATE
2051

A TUBECHECKER *for industry*

TESTS: **Receiving Tubes, Voltage Regulator Tubes, *low power* Thyratrons**

The WESTON Model 798 Mutual Conductance Tubechecker provides, for the first time, adequate tests on voltage regulator tubes, light-duty Thyratrons such as the 884, 885, OA4, 6D4, 2A4, 2050, 2051 in addition to tests on regular receiving tubes. Ranges of 12,000, 6,000, 3,000 micromhos as well as "Good-Bad" indications cover the tube checking requirements of electronic control and radio circuits. Housed in rugged aluminum case to withstand rough usage in shop or field.

For full details consult your local WESTON representative, or write . . . WESTON Electrical Instrument Corp., 617 Frelinghuysen Ave., Newark 5, N. J.

WESTON *Instruments*

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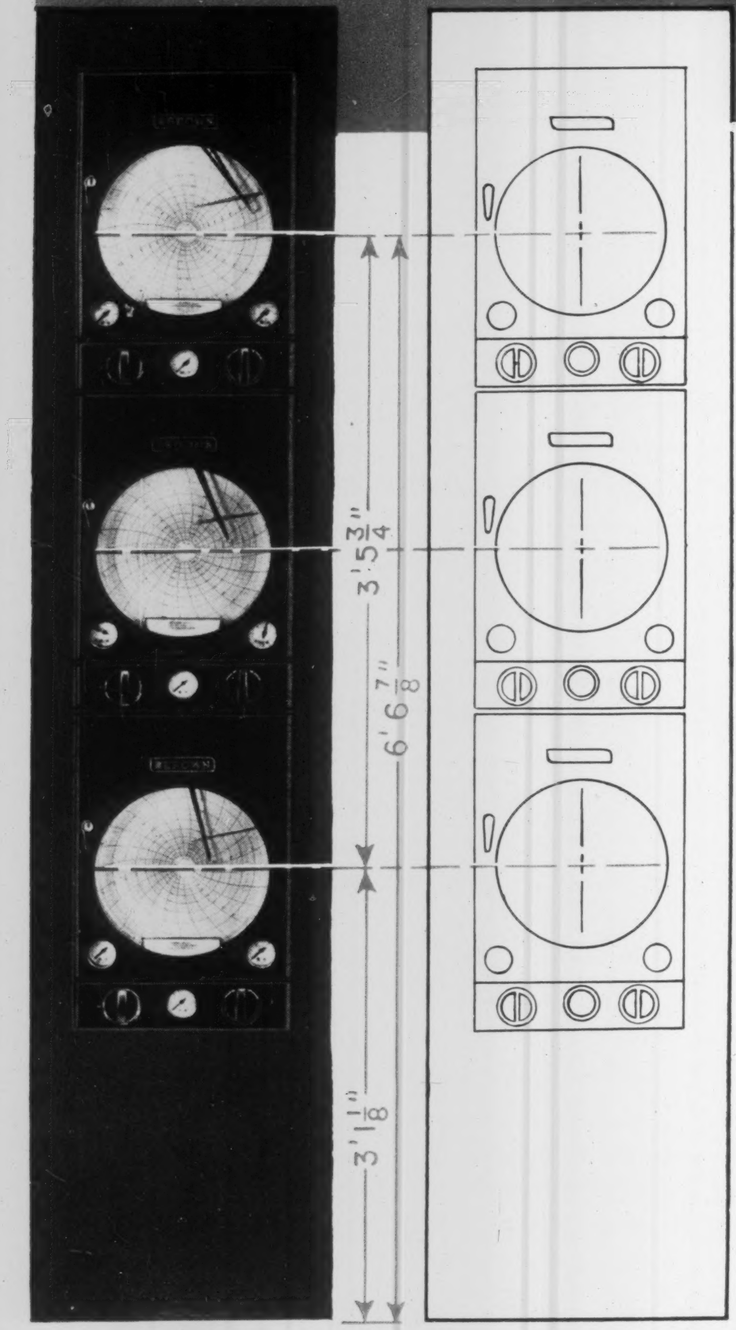
New INTEGRAL CONTROL BY-PASS

has the 8 features you specified*



The *Integral* Control By-Pass permits 3-high mounting with easy visibility and accessibility. The pleasing continuous vertical column effect improves the group mounting appearance.

* 103 Chemical and Petroleum Engineers helped design it.

1 SAVES PANEL SPACE

The Brown *Integral* Control By-Pass permits 3-high mounting without taking any more panel space than is normally occupied by three instruments without by-passes.

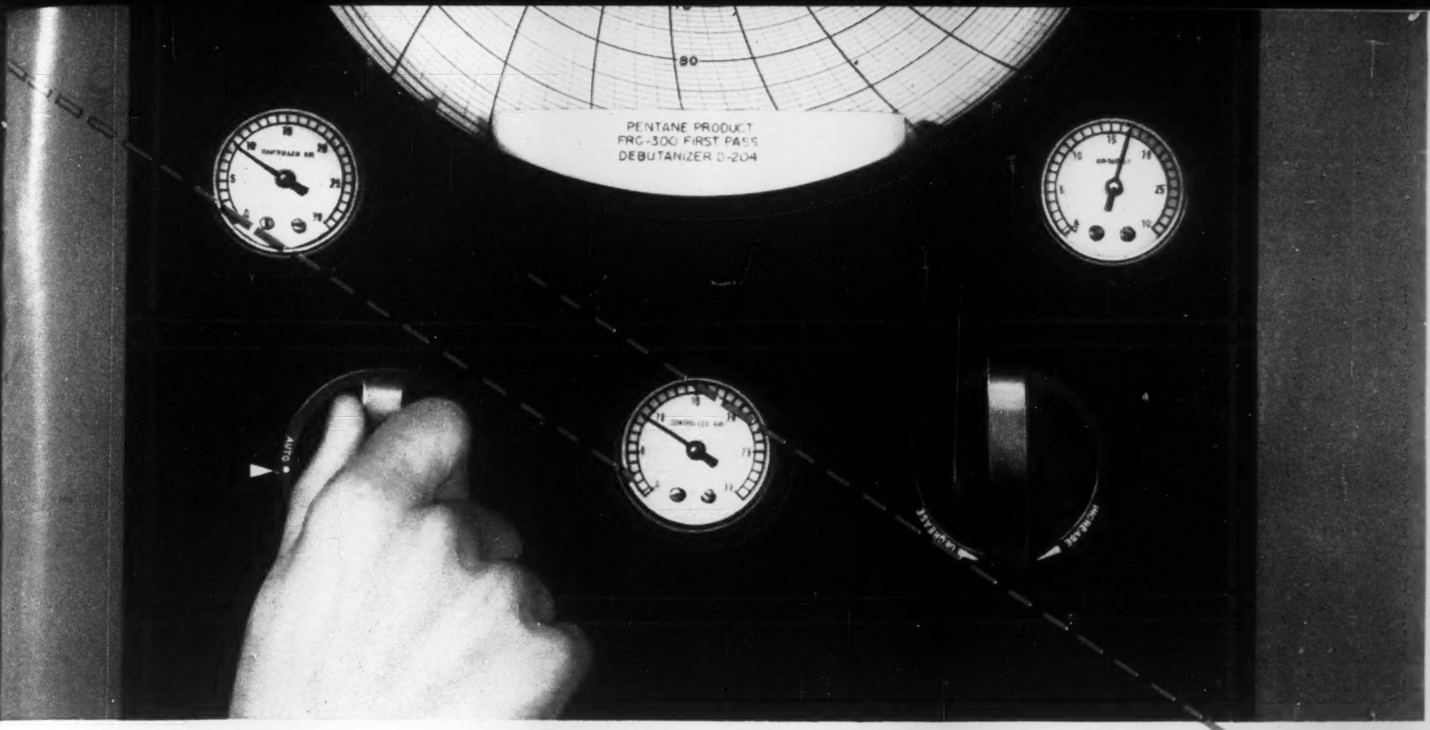
It has been designed with the help of 103 petroleum and chemical engineers to blend desired features into a practical operating form. No compromise has been made in the instrument design nor in the convenience of operating the by-pass.

2 SHIPPED AS A UNIT— Only Two Air Connections Needed

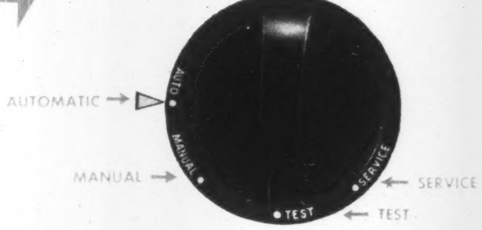
Each instrument and its control by-pass are shipped as one *integral* unit. Because there are normally only two air piping connections to be made on the job, piping is minimized and installation costs are greatly reduced.

3 INSTRUMENTS SEPARATELY REMOVABLE

With the switch in the "service" position, the instrument can be removed, allowing the by-pass to remain for manual control. Disconnection is made by the removal of two screws.



4 FOUR SWITCH POSITIONS



The switching valve employs the plug principle which has proven so satisfactory under wide variations of operating conditions. It provides a bubble-tight, metal-to-metal seat and contains no gaskets to wear nor spring to corrode.

5 NEW PRESSURE REGULATOR ELIMINATES DRIFT

A completely new pressure regulator (operated by the right-hand grip) incorporates two major characteristics: (1) minimum drift and (2) fast response. This new regulator is of the null balance type and can be minutely adjusted for close control settings.

6 ACCESSIBLE WITHOUT OPENING CASE

Switching from "automatic" to "manual" does not require opening of the instrument case. When on "automatic," all switch grips are vertical.

Integral, rather than internal, mounting obviates crowding of components and gives the user flexibility in the selection of control combinations.

7 SWITCHES WITHOUT PROCESS UPSET

Ease of switching from automatic to manual control without process upset is an important operating feature. The "controlled air" gauge (in the instrument) and the "manual" gauge (in the by-pass) are close together and are of the same size and shape. When switching from "automatic" to "manual," it is not necessary to match gauges of different sizes and method of pointer travel. When air pressures on the two gauges are equal, the pointers will have the same inclination and chances of error are minimized. All air gauges are located at the bottom, so that even the top instrument can be set with ease and accuracy.

8 NO OBSOLESCENCE

Current models now in operation are adaptable to the new *Integral* Control By-Pass. Furthermore, working parts such as control units, *Indexets*, actuating elements and other components now familiar to your maintenance force are still used.

WRITE FOR CATALOG 2221

The new *Integral* Control By-Pass is completely described in Catalog No. 2221. A copy will be sent to you without obligation.

BROWN
Air-o-Line
DIFFERENTIAL
CONTROLLERS
For FLOW and LIQUID LEVEL

THE BROWN INSTRUMENT COMPANY
4482 WAYNE AVENUE, PHILADELPHIA 44, PA.
DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR CO.
SUBSIDIARY COMPANIES IN TORONTO • MEXICO CITY • LONDON • STOCKHOLM • AMSTERDAM • BRUSSELS

BROWN *Instruments and Controls*

FOR THE INDUSTRIES

Wherever you Employ Magnets, Check with us on the Advantages of using

ARNOLD

PERMANENT MAGNETS

As electrical constituents go, permanent magnets are relatively new. They made tremendous advances within the past decade, especially in the communications and aviation industries, and in the general fields of instruments, controls, meters and mechanical holding devices.

Many of these uses were problems that just couldn't be solved until permanent magnet materials were developed to do the job—a work of pioneering to which Arnold contributed a heavy share. Many other applications were those where permanent magnets supplanted older materials because of their inherent ability to save weight, size and production time, as well as greatly improve the performance of the equipment.

To these advantages, Arnold Permanent Magnets add another very important value—standards of quality and uniformity that are unmatched within the industry. Arnold Products are 100% quality-controlled at every step of manufacture. What's more, they're available in all Alnico grades and other types of magnetic materials, in cast or sintered forms, and in any shape, size or degree of finish you need.
● Let's get our engineers together on *your* magnet applications or problems.

THE ARNOLD ENGINEERING CO.

Subsidiary of

ALLEGHENY LUDLUM STEEL CORPORATION

147 East Ontario Street, Chicago 11, Illinois

Specialists and Leaders in the Design, Engineering and Manufacture of PERMANENT MAGNETS

W&D 1296

Write for Descriptive Literature

Wheelco CAPACILOG

A NEW *Electronic* SCRIBER

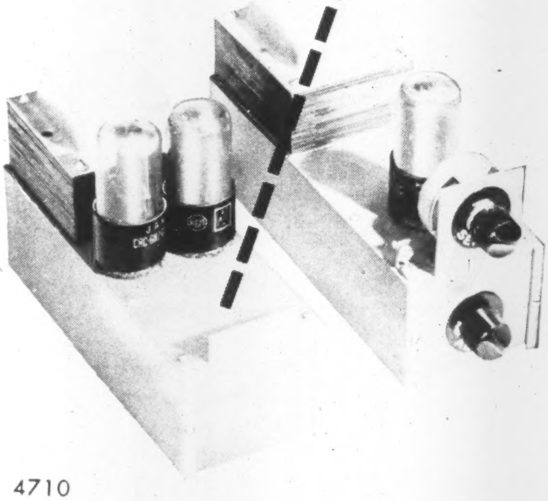
WHEELCO CAPACILOG

Wheelco, in creating the "*ELECTRONIC PRINCIPLE*" for pyrometric Control paved the way for faster, simpler and more accurate industrial Process Regulation.

Years of research, engineering and experience in practical application of Electronic Controls all over the world, now culminate in the production of the WHEELCO CAPACILOG, an electronic recording indicating or controlling instrument.

This simplified "ELECTRONIC SCRIBER" combines the "no-contact" features of the universally accepted Wheelco Capacitrol with a revolutionary mechanical design of rugged construction, perfected to fine watchmakers' precision.

The CAPACILOG is available as a *Deflection, Potentiometer* or *Resistance Thermometer Type Recorder, Recording Controller* or *Indicating Controller.*



CAPACILOG FEATURES

- **Wheelco "Electronic Principle"**
- **Direct Reading**
- **No Converters—No Relays**
- **Plug-In Chassis Design**
- **Multi-Tube Safety Factor**
- **Voltage Selector Plug**
- **Swing-Out Chart**
- **Automatic Chart Reroll**
- **Backlash Breaker**
- **Standard Electronic Tubes**

4710

WHEELCO *Electronic* INSTRUMENTS

Recorders · Controllers · Combustion Safeguards

Wheelco Instruments Company, 833 W. Harrison St. Chicago 7, Ill.

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FUEL
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12

Easy on the eyes!

U. S. Radium Luminescent Dials enable pilots to see better

Leading aircraft-instrument makers choose U. S. Radium dials because of their bright, long-lived luminescence and accurate markings

Above you see one of four types of indicators, equipped with U. S. Radium dials, which are supplied with the Simmonds Pacitor Gauge — a highly reliable, electronic fuel gauge manufactured by Simmonds Aerocessories Inc., New York, and currently being installed in Douglas DC-6, Lockheed Constellation, Consolidated Vultee 240, and other aircraft.

Pilots of the new super-airliners have plenty of instruments to read! To make the dials as legible as possible . . . and especially to eliminate glare at night . . . commercial airlines specify that all letters, numerals, and graduations on scales must be self-luminous.

To meet this specification with assurance of full satisfaction, leading aircraft-instrument manufacturers use U. S. Radium dials and pointers. The bright self-luminous markings — precisely applied — are easy to read in daylight, artificial light, or darkness.

LUMINESCENT DIALS FOR OTHER INSTRUMENTS

U. S. Radium is producing dials for a wide variety of instruments and timepieces — using long-lived luminescent materials in a range of brilliant, standardized colors.

The services which U. S. Radium offers you include (1) designing dials for luminescence; (2) start-to-finish production of luminescent dials, pointers, or other components; (3) application of self-luminous, fluorescent, or phosphorescent materials to existing dials; (4) production of highly precise nonluminescent dials. To find out how any of these services may increase the utility, accuracy, or saleability of *your* instruments, write to *Dept. 19. U. S. Radium Corp., 535 Pearl St., New York 7, N. Y.*

UNITED STATES RADIUM

Luminescent Dials

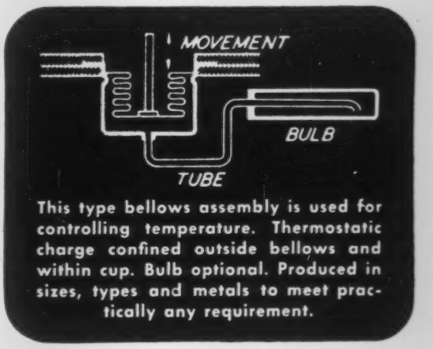
He's sweating out mis-fits . . .

TESTS of Fulton Sylphon custom-made bellows assemblies are tough . . . as you can see in the picture of the thermostat assembly test above. They must meet rigid specifications. If they don't, they're mis-fits—they never leave the factory.

Such extreme care is taken for one reason: to insure that product performance will be completely satisfactory. Nothing less will do.

For over 43 years Fulton Sylphon has specialized in the development and production of metal bellows, bellows assemblies, and bellows devices . . . and has never relaxed its high standards of workmanship. That's why designers and engineers in practically every industry rely on Fulton Sylphon for help in solving problems involving the control of temperatures and pressures.

Perhaps you have a product, or are planning one for which these assemblies are "just the ticket". They do hundreds of jobs—such as opening and closing valves, sealing shafts, sounding warning signals, turning engines on and off. Write our engineers for helpful advice. And send for Catalog VE-1200. It contains a wealth of valuable information and idea-stimulators.



This type bellows assembly is used for controlling temperature. Thermostatic charge confined outside bellows and within cup. Bulb optional. Produced in sizes, types and metals to meet practically any requirement.

Temperature Controls • Bellows Devices • Bellows Assemblies

FULTON SYLPHON

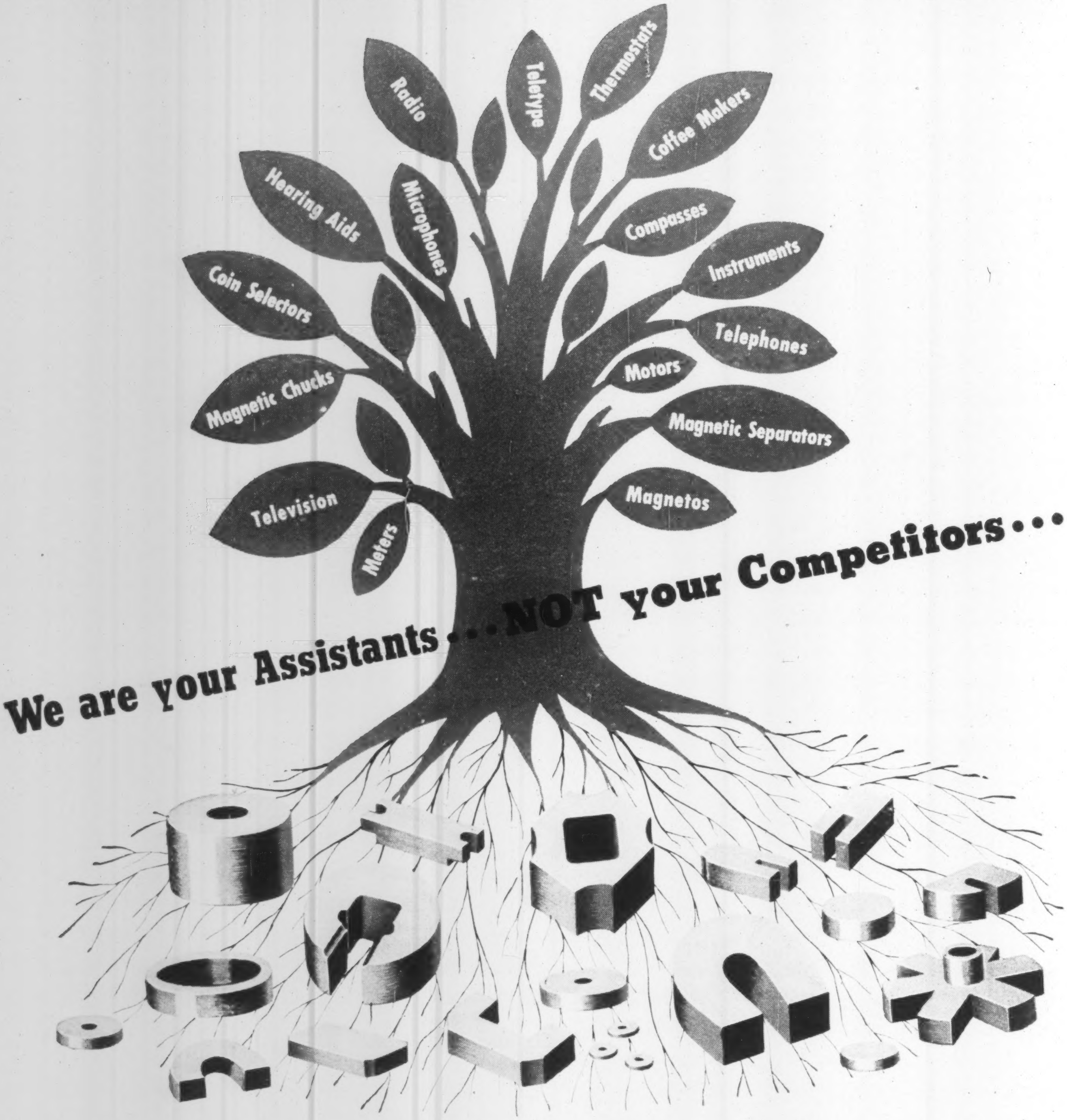
DIVISION

FIRST WITH BELLOWS

ROBERTSHAW-FULTON CONTROLS CO. KNOXVILLE 4, TENN.

Canadian Representatives, Darling Brothers, Montreal

PERMANENT MAGNETS MAY DO IT BETTE


Radio
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Compasses
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Television
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We are your Assistants...NOT your Competitors...

We make no end products. We have no allied branches. These two facts are important to our customers. They can discuss their problems and product designs freely with us, knowing that their confidence will be respected. Thus your problem becomes our problem, and our advantage of 37 years of permanent magnet designing becomes your advantage.

This is only one of the many reasons why The Indiana Steel Products Company is headquarters for Permanent Magnet research, why more than 25,000 individual applications have been developed by our engineers, why we are the world's largest producer of permanent magnets which utilize every conceivable permanent magnet material.

You are invited to consult with our engineers on any magnet problem. We assure you your confidence will be fully respected.

★ THE INDIANA STEEL PRODUCTS COMPANY ★

PRODUCERS OF "PACKAGED ENERGY"
6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILL.
SPECIALISTS IN PERMANENT MAGNETS SINCE 1910

PLANTS { VALPARAISO, INDIANA
CHAUNCEY, WESTCHESTER COUNTY, N. Y.

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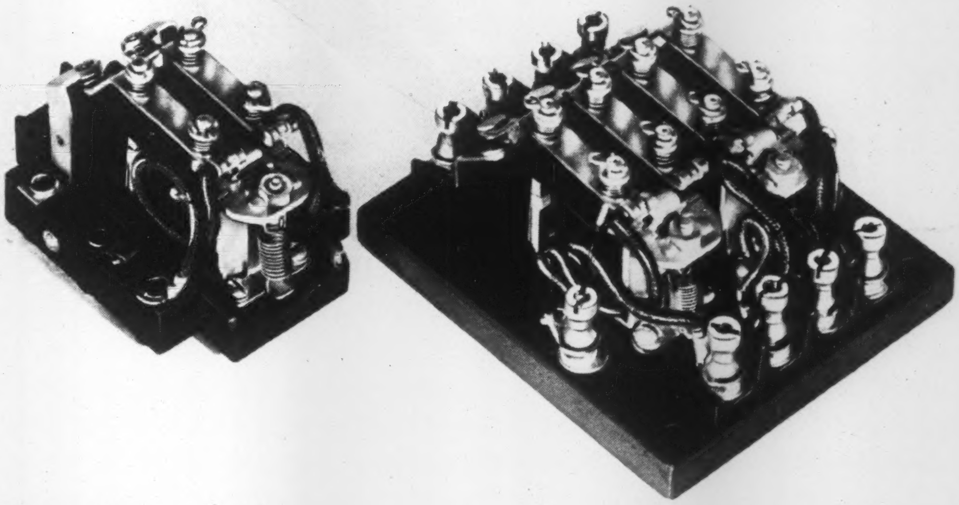
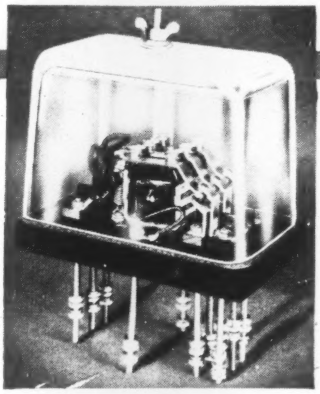
STRUTHERS-DUNN

Midget Relays





Glass enclosed type for switchboard mounting

SMALLEST SIZES CONSISTENT WITH DEPENDABLE OPERATION

- Designed for long, trouble-free performance wherever space, weight or moderate cost are important considerations. Available for a.c. or d.c. use as specified. *Exceptionally quiet on a.c. applications.* Conservative contact ratings (based on heater load values) are:

6 amps. at 115 volts a.c.
3 amps. at 230 volts a.c.
0.5 amp. at 115 volts d.c.

- Underwriters' approved. Individually tested. Ideally suited for built-in applications, control of small motors, heaters, audible and visual signals, lamp control and various other uses. Special adaptations available for radio-frequency, low-voltage loads, audio-frequency loads and other exacting uses.

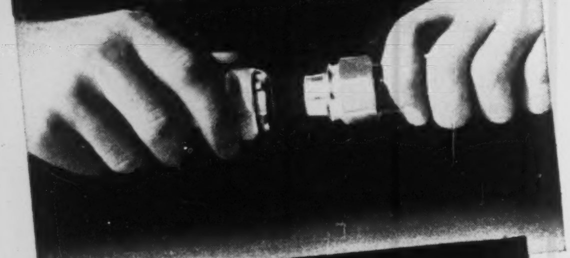
Write for Struthers-Dunn Midget Relay Bulletin

5,327 RELAY TYPES **STRUTHERS-DUNN, Inc.** 150 N. 13th St., Phila. 7, Pa.

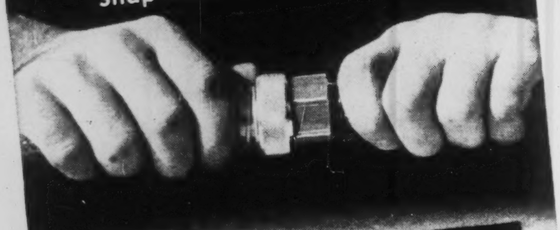
ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DALLAS
DENVER • DETROIT • HARTFORD • INDIANAPOLIS • LOS ANGELES • MINNEAPOLIS • MONTREAL
NEW YORK • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

NOW!
RONAFLEX

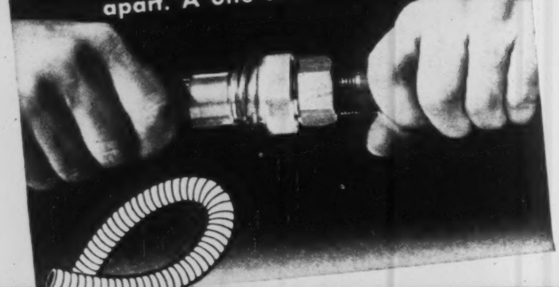
INSERT...
Simply insert coupling ends.



SNAP...
Snap knurled collar forward.



SNUG...
Fits tight, won't leak, can't come apart. A one-second operation.



a flexible tubing of 1001 uses

with hi-speed snap-on couplings that save time . . . cut costs . . . speed work

Here is a revolutionary new type of tubing with the flexibility of rubber . . . the sturdiness of steel. Ronaflex is a synthetic rubber tubing protected by strong steel braiding cover that provides extreme flexibility, tight free-flowing transmission of air, water, gases, oil, volatiles.

For quick, tight connection, Ronaflex tubing is available with hi-speed snap-on aluminum couplings that resist rust, prevent leakage, save time. Simply snap on, snap off—a one-second operation! Precision-made, they withstand severe vibration and pressures up to 500 p.s.i. without leakage.

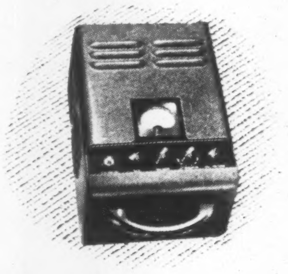
Designers, engineers, plant managers will find Ronaflex tubing assemblies ideal for economical use everywhere: fuel and oil lines for engines, machine tool coolant lines, butane-propane gas lines, paint spraying air lines, for rapid testing operations, and countless other applications. Write for complete data. Ronaflex tubing assemblies, manufactured by the Ronaflex Tubing Co., Inc., are distributed exclusively by . . .

PENFLEX SALES COMPANY
Division of
PENNSYLVANIA FLEXIBLE METALLIC TUBING COMPANY
7212 Powers Lane Philadelphia 42, Pa.
BRANCH SALES OFFICES—BOSTON • NEW YORK • SYRACUSE • CLEVELAND • CHICAGO • HOUSTON • LOS ANGELES

Penflex... HEART OF INDUSTRY'S LIFE LINES

Copyright 1947—Penflex Sales Co.

This Oscillograph draws an INSTANT picture of electrical impulses!



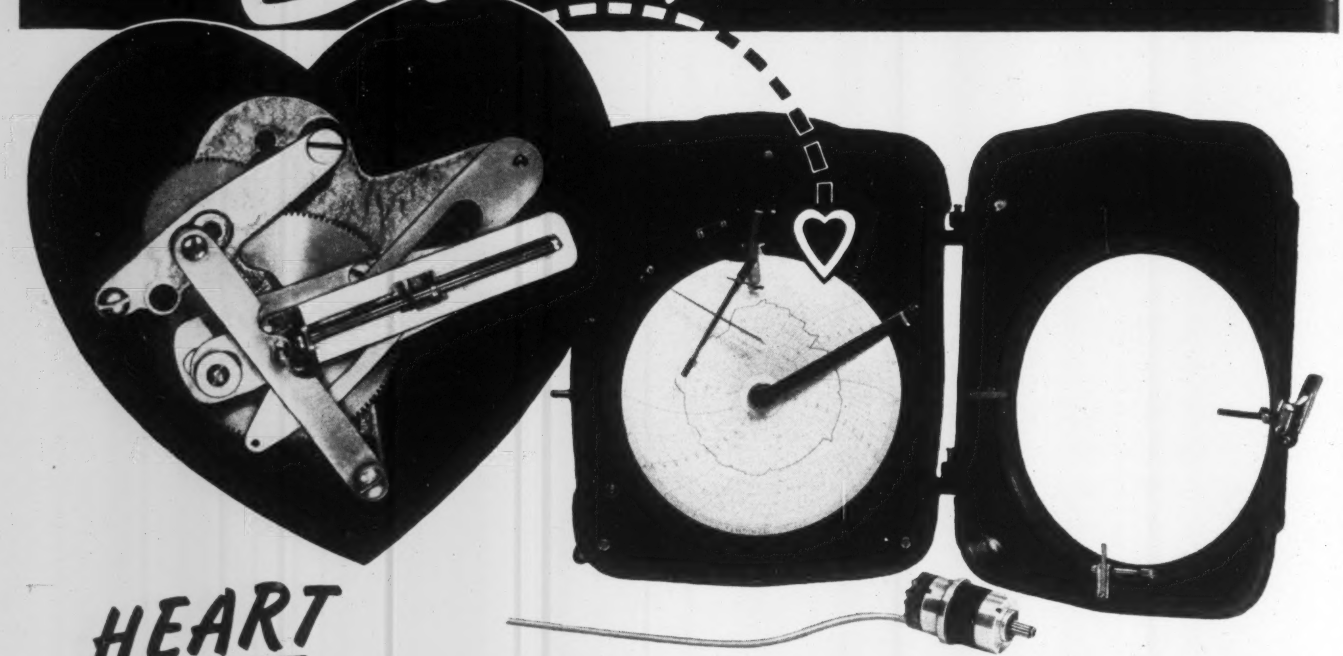
Brush Model BL-913 D.C. Amplifier. Well adapted to the measurement of static or dynamic phenomena such as temperature, light, pressures, strains, etc.

Today when saving time costs is so important, your best bet for an *immediate* picture of electrical impulses is with Brush Oscillographs. No more delays with photographic development. *Instantaneous*, permanent, ink-on-paper recordings by Brush Oscillographs make their use almost unlimited. Accurate recordings of strains, pressures and countless electrical phenomena can be made over a frequency range of D.C. to 100 c.p.s. Today Brush Oscillographs are available in Single, Double and Six Channel models. The magnetic Pen Motor is available separately for incorporation into equipment such as medical, geophysical and other highly specialized designs. Whenever desired, recordings may be stopped for notations on chart-paper.

Write today for detailed bulletin.

The Brush Development Co.
3419 PERKINS AVENUE • CLEVELAND 14, OHIO
Canadian Representatives: A. C. Wickman (Canada) Ltd., P. O. Box 9, Station N, Toronto 14

Servograph



HEART OF A *NEW* FIELD OF RECORDER APPLICATIONS

POSITION vs. TIME

● Servograph is a new type graphic recorder utilizing a circular chart with an inking pen which is motivated from a remote point by war proven synchros. Synchro is the U. S. Navy's designation for a special type of self-synchronous motor which provides accurate duplication of motion when two are connected in parallel.

Operating from the receiving synchro is the heart of the Servograph—an extremely accurate variable ratio device which connects to the pen arm. This mechanism makes the Servograph so flexible that a single adjustment will provide full chart coverage with any given rotation within the range of ½ to 10 revolutions. This unusual feature permits accurate recording of any remote variable which can be converted to angular rotation of the transmitting synchro. Included are pressure, temperature, liquid level, and most mechanical movements.

"Records Almost Anything That Is Capable of Being Converted Into Angular Motion"

SERVO-TEK will assist you in applying the Servograph to your particular requirements.

WRITE FOR FREE BULLETIN

SERVO-TEK PRODUCTS CO.
INCORPORATED
Manufacturing Division
CLIFTON, NEW JERSEY

YOUR TELEPHONE TRANSMITTER AND RECEIVER, *voice gateways to the telephone plant, are so essential to satisfactory service that they have been under study in Bell laboratories for seven decades.*

TESTING TELEPHONES BEFORE THEY ARE BUILT

A TELEPHONE RECEIVER is a complex system of electrical and mechanical elements. Its coils, magnets, diaphragm and cap react on each other as they convert the electrical waves of your voice to sound waves. What is the best size for the holes in the ear cap? Will 1/1000th inch greater thickness help a receiver diaphragm to carry your telephone voice more clearly? One way to find out is to build numerous experimental receivers and test them.

But Bell Laboratories have found a shorter way. They built an all-electrical replica, an "equivalent circuit" in which electrical resistance stands for air friction in the cap holes; capacitance corresponds inversely to the stiffness of the diaphragm. Over-all performance of this circuit can be quickly measured and design changes economically explored. Later, a model can be built for final check.

The "equivalent circuit" was pioneered by Bell Telephone Laboratories 25 years ago. It is a useful tool in many Laboratories developments—saving time, saving the cost of machine-tooled models, encouraging experimentation. It is one more example of the way Bell scientists get down to fundamentals as telephone progress continues—and service keeps on improving for all subscribers.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

NORTH AMERICAN

ADJUSTABLE PORT VALVES OPERATED BY ANY TYPE OF CONTROL MOTOR

PROPORTION AND CONTROL THE FLOW OF GASES AND LIQUIDS

MINNEAPOLIS-HONEYWELL REGULATOR CO.
LEEDS & NORTHRUP COMPANY
AUTOMATIC TEMPERATURE CONTROL CO.
NORTH AMERICAN
HAROLD BECK COMPANY
BARBER-COLMAN COMPANY
WHEELCO INSTRUMENTS CO.

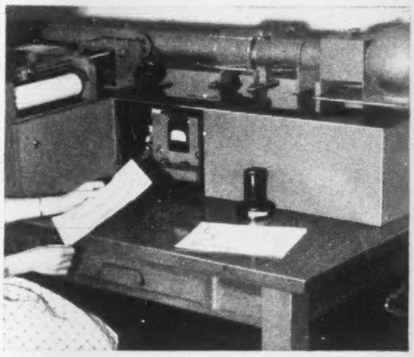
The use of North American adjustable port valves is desirable whenever a definite minimum and maximum flow of a medium is required and where it is necessary to vary that flow intermittently or continuously between these limits. They can be used singly, or in pairs when simultaneous and proportional control of two mediums is advantageous.

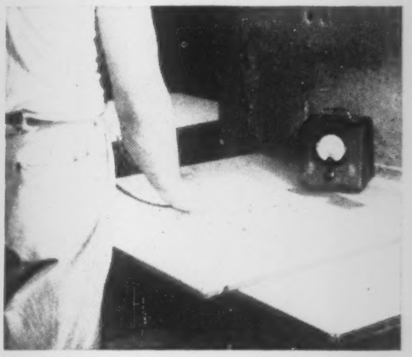
THE NORTH AMERICAN MANUFACTURING COMPANY

MANUFACTURERS OF INDUSTRIAL FUEL BURNING EQUIPMENT FOR GAS OR OIL

BRANCH OFFICES *with* FIELD ENGINEERS *in* PRINCIPAL CITIES

How GE Specialized Testing Equipment *Cuts Production Costs*





Viscosimeter Saves Its Cost in One Month

By enabling the Cleveland Steel Barrel Company to improve control and uniformity of the finish on its steel shipping containers, the Zahn viscosimeter saved its first cost in a month. Rejects from stickiness and the need for repaint jobs were eliminated. The Zahn viscosimeter has many similar applications for the users of varnish, lacquer, japan, syrups, and other liquids. Write for Bulletin GEA-3618C.

Spectrophotometer Pays Its Way in One Project

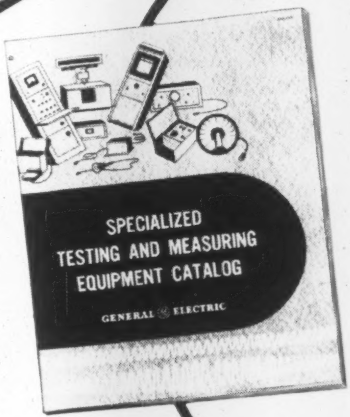
Ten years ago, the Harshaw Chemical Company developed a new opacifier, Uverite, to replace tin oxide. On this project, a G-E recording spectrophotometer more than paid for itself. But the important news is this: Harshaw's chemists say it has been paying for itself repeatedly since then by giving quick, permanent results for color analysis, comparison work, etc. Write for Bulletin GEA-3680A.

Thickness Gage Saves $600 Monthly

In determining the amount of white enamel needed on stove parts by its thickness, this gage saves Florence Stove Company $600 monthly. This includes savings from the reduction of rejects and from speeding up the enameling process. G-E thickness gages measure the thickness of any nonmagnetic material on a magnetic iron or steel base. Range: from 0.00005 to 0.75 inch. Write for Bulletin GEA-4363A.

NEW FREE CATALOG FOR REFERENCE AND ORDERING

This new SPECIALIZED TESTING AND MEASURING EQUIPMENT CATALOG contains 44 pages of the latest in measuring and testing equipment, giving application, description, specifications, photographs, prices, and how to order. Here, in easy-to-use form, information is assembled about approximately 100 equipments. If you can use a catalog of this type, fill out the coupon completely and send it today.



These are three of many cases where General Electric laboratory equipments cut costs in laboratory and factory procedures.

If you have a specialized testing problem, we shall be glad to investigate for an effective and economical answer. Apparatus Department, General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

General Electric Co., Section H 800-37
Schenectady 5, N. Y.

Please send me the new SPECIALIZED TESTING AND MEASURING EQUIPMENT CATALOG GEA-639.

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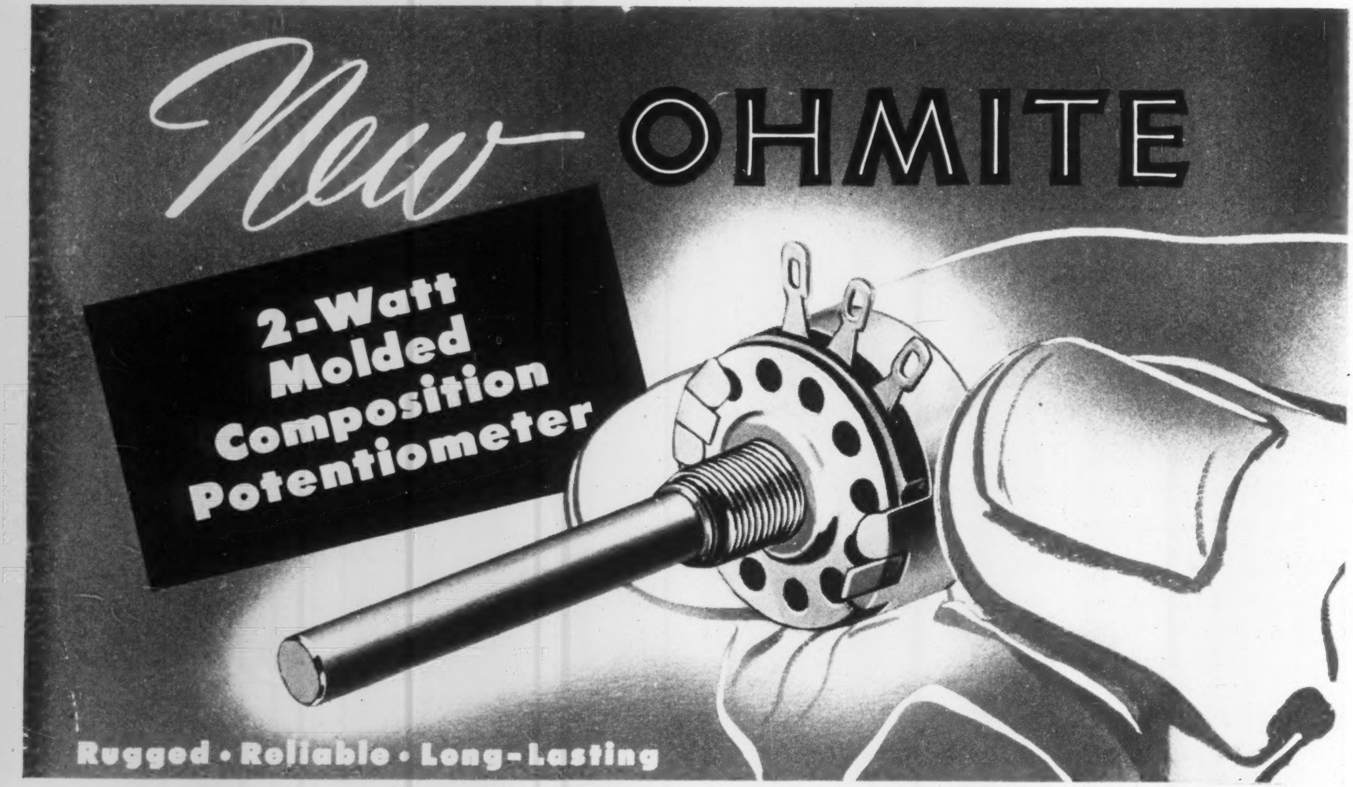
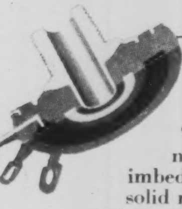

New OHMITE
2-Watt Molded Composition Potentiometer
Rugged • Reliable • Long-Lasting

A high quality unit... withstands heat, cold, moisture and severe service

● Nothing like this potentiometer has ever been offered to the industrial market through the radio parts distributor. It is primarily a high quality unit—built to last. The resistor material is not of the paint or film type, but is solid molded. Heat, cold, or moisture cannot affect it. Wear does not change its contact resistance, hence the control retains its very low noise characteristic. Furthermore, it has a 2-watt rating with a good safety factor.

Sold only through Ohmite distributors

Specifications



Terminals are imbedded in solid molded resistor element.

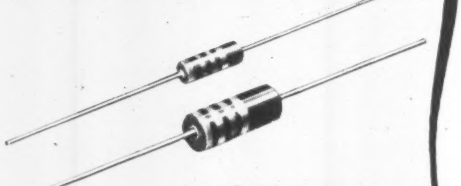
RESISTANCE: Max resistance values, 50 ohms to 5 megohms in linear taper. Also logarithmic tapers in limited ranges.

POWER: Max continuous rating at 100% rotation —2.25; 50%—2.0; 25%—1.3.

VOLTAGE: Max cont. across entire resistor, 500 volts provided wattage rating is met.

AMBIENT TEMP: From —60 C to + 100 C.

...another NEW Ohmite item



± 5% TOLERANCE

LITTLE DEVIL COMPOSITION RESISTORS

● These popular resistors are now available in ½- and 1-watt sizes in tolerances of ±5%—in addition to the standard ±10% units. The resistance and wattage are clearly marked on every unit. *Sold only through Ohmite Jobbers.*

OHMITE MANUFACTURING CO.

4887 Flournoy Street, Chicago 44, Illinois

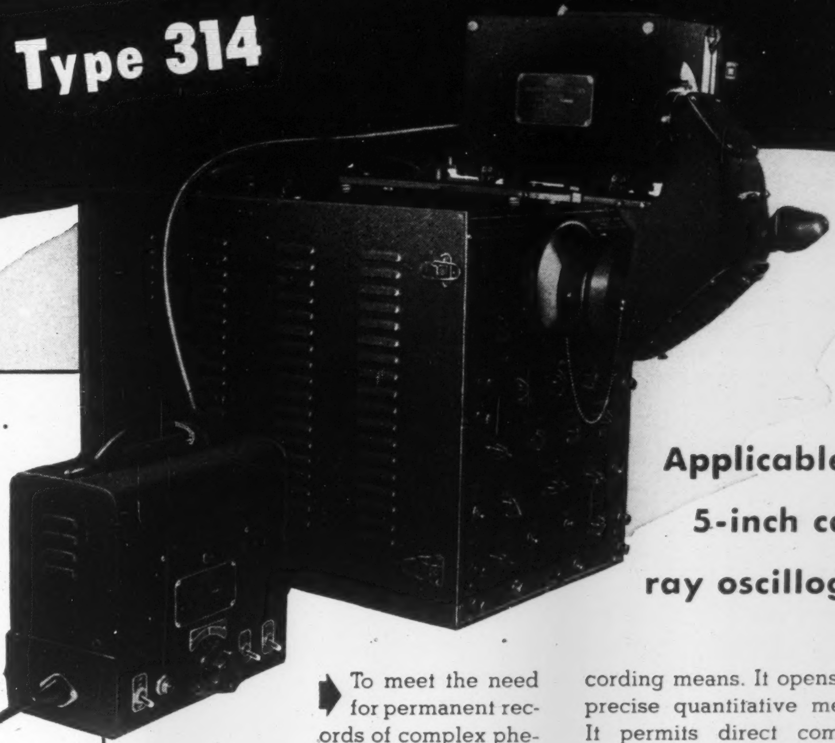
Be Right with OHMITE

RHEOSTATS • RESISTORS • TAP SWITCHES • CHOKES • ATTENUATORS

DU MONT *announces the new . . .*

CONTINUOUS-MOTION/SINGLE-IMAGE OSCILLOGRAPH-RECORD CAMERA

Type 314



AVAILABLE NOW FOR DELIVERY FROM STOCK IN LIMITED QUANTITIES

SPECIFICATIONS...

- ✓ Wide range of film speeds (3600 to 1) — from 1 inch per minute to 5 feet per second.
- ✓ Instantaneous change from low- to high-speed recording.
- ✓ Calibrated electronic speed control (in./min. and in./sec.)
- ✓ Quickly detached to free oscillograph, or for use with other oscillographs.
- ✓ Fixed-focus f/2.8 or f/1.5 lens for medium- or high-speed recording.
- ✓ Capacity of 100 feet of 35 mm. film or paper; provision for 1000 feet if required. Film footage indicator.
- ✓ Operates independently of ambient light. Simultaneous viewing and recording of trace.
- ✓ Self-illustrated data card for labeling given "takes" directly on film. Provision for timing markers.

Applicable to ALL 5-inch cathode-ray oscillographs!

➧ To meet the need for permanent records of complex phenomena, Du Mont proudly presents a camera capable of photographing all types of traces — high or low frequency; periodic or aperiodic; continuous-motion or single-image; and for time intervals up to 200 hours.

The new Du Mont Type 314 Oscillograph-Record Camera* provides all users of cathode-ray oscillographs with a useful, simple, practical recording means. It opens the way for precise quantitative measurements. It permits direct comparisons of traces recorded at different times under varying conditions.

For maximum convenience, the mounting, operation and dismounting of this camera are reduced to simplest terms consistent with the requirements and practices of the widest range of oscillograph users.

• • •

*Manufactured for Du Mont by Fairchild Camera and Instrument Co.

➧ ***Descriptive literature on request.***

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DUMONT *Precision Electronics & Television*

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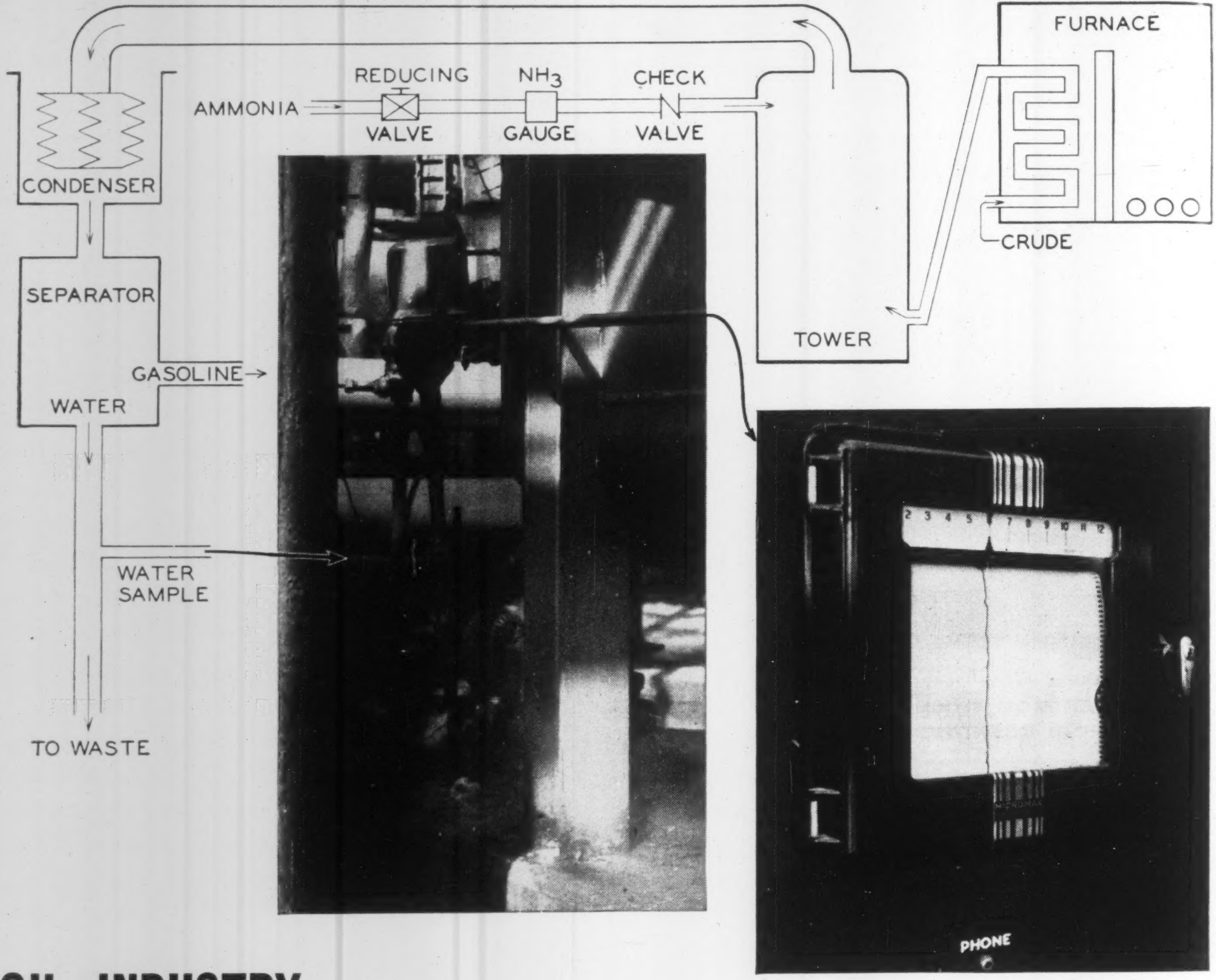

OIL INDUSTRY

FIGHTS CORROSION WITH MICROMAX pH RECORDERS

One of corrosion's most effective enemies in many refineries is the Micromax Recorder which continuously shows the pH of water at various plant locations. At present, these are the three principal opportunities:

1. Dehydrator water. A Micromax record of this pH helps prevent both overtreatment and undertreatment of acid crudes.

2. Hydrofluoric Acid processes. Here any leak affects pH instantly, and the sensitivity and dependability of Micromax Recorders make them particularly valuable for prompt detection of leaks and the heading-off of resultant corrosion.

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EDITORIALS

By M. F. BEHAR

Electron Tubes in Instrumentation

IT is an old saying, yet an apt one, that no scientific discovery is evil in itself but that some men put some discoveries to evil uses.

It often has been said also that most men—not some but most—become unduly fascinated by some discoveries, inventions or mere new gadgets. At this season, for example, most fathers who have bought mechanical toys for their sons are playing with these toys.

We're not against electron tubes; on the contrary, we're convinced that they represent one of the greatest modern developments. We're not against their use as components of measurement and automatic-control circuits; on the contrary, we're convinced that this use of tubes benefits science and industry.

Likewise we are FOR electronics—just as we are for statics, kinematics, kinetics, dynamics, hydraulics, pneumatics, acoustics, optics . . . and electrostatics and electrokinetics and good old electromagnetism! Which is to say that we are not against but FOR

Electronics. 70.05.005. That branch of science and technology which relates to the conduction of electricity through gases or in vacuo. [American Standard Definitions of Electrical Terms.]

We're NOT against the MEN—the play-with-toys men, the perfectly normal men—who use electron tubes indiscriminately and sometimes dangerously.

But we're against the unwise or risky use of electronic components. Likewise we're against the unwise or hazardous use of ANY component whether mechanical or hydraulic or pneumatic . . . or electromechanical or magneto-optic or photoconductive or piezoelectric or magnetostrictive or thermoelectric or electrochemical . . . or capacitive or resistive or inductive or reactive!

By indiscriminate or unwise or injudicious use, we mean for example the use of a $500 remote position-repeating system when a piece of string would do, or the use of a piece of string when logical considerations dictate the use of a high-precision repeater (mechanical or electrical) regardless of cost.

By hazardous or dangerous or risky use of components we refer, of course, to the application—the process or machine or weapon—on which the instruments are installed; and to the consequences of malfunction or failure of the instruments.

If the application is a high-pressure boiler in a power plant in the middle of a town, or a large-scale chemical process, or a blast furnace, or an anti-aircraft installation, then every component of every measurement and automatic-control system must be as nearly infallible as human ingenuity can make it. No type of component is absolutely infallible. All fail sooner or later. The two important facts to be borne in mind are: (1) the great majority of NON-electronic components do NOT fail unpredictably or unexpectedly; (2) the great majority of electron tubes fail unpredictably or unexpectedly. Even the high-priced tubes made for telephone-repeater and railway signal service fail after UNPREDICTABLE periods.

It would not be fair to call electron tubes "unreliable." The right word is "unpredictable." No amount of care and ingenuity in manufacture can prevent tubes going bad—even on the stock shelf a few months or days after final inspection: it's simply a matter of mathematical probability arising from the great number of factors entering in tube construction assembly, etc.*

Of vital importance is the question of what happens to a controlled process upon failure of the power supply which is utilized by the control instruments to operate the valves, dampers, etc. This question has two distinct aspects:

(1) The first is the enormous advantage of pneumatic control systems in the event of power failures: NOTHING happens to the controlled process when the interruption is brief, because the compressed-air storage tanks have enough capacity for several minutes' operation of all valves, dampers, etc. (In vitally-important installations, capacity is simply increased to take care of hours of operation).

(2) IN GENERAL, electrical, pneumatic, hydraulic or mechanical components simply take up where they left off when the power failed. The instruments usually remain "in position" and resume without attention (other than minor jobs such as turning charts by hand to the right time). IN GENERAL, electronic components cause severe upsets. Only electronic components require WARMING-UP after a power failure. This sometimes is extremely serious because if an over-eager operator connects the controlled circuit too soon, two or more not-yet-warm tubes will function momentarily as an oscillatory circuit.

A prominent user told us that his hair almost turned white on several occasions when he feared that operators would not have the patience to wait—and in some applications the necessary virtue is not patience but bravery, for even a few seconds' power interruption is risky and the prolongation of no-control by reason of tube warm-up might cause a disaster with heavy loss of life. *Theoretically*, it is possible to design for *any* application a circuit whereby oscillations after resumption of power will be prevented; in practice this has been done in only a relatively few cases.

Electron tubes are here to stay—in automatic-control systems as well as in a multitude of other devices. They perform certain functions supremely well. Therefore, to try to drive them out of our field would be injudicious as well as futile. To drive them out of those AUTOMATIC-CONTROL applications where they DON'T belong is the obvious duty of influential instrument engineers.

Electron-tube functions, such as rectification, amplification or oscillation, can be performed by non-electronic devices. (Even radio stations and radio receiving sets could be built without tubes.) The undeniable advantages of tubes drove out of radio the rotary oscillator, the crystal set and other non-electronic equivalents. Now, however, a reversal of the trend is discernible—not in radio but in instrument engineering—at present only in a few critical applications such as automatic-control systems where tubes are being replaced by magnetic components. What magnetic components? One important but little-known* category will be described in our next issue.

—MFB

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*Read "Tube Failures in ENIAC" by F. R. Michael of Penn'a Univ. in the Oct. 1947 *Electronics*, page 116-119. This article reports statistics on 644 "tubes removed" from the 18,800-tube computer. Read especially the editorial note on page 116—for which *Instruments* salutes *Electronics*.

*Though dating back to Dr. Alexanderson's 1916 patent.

Machine-tool Instrumentation

IN Chicago the instrument exposition of September 8-12 at the Stevens Hotel was followed by the machine-tool exposition Sept. 17-26 at the 12-acre Dodge-Chicago plant—the only building in the country that could accommodate under one roof three miles of aisles where 2021 machine tools in actual operation were viewed by a hundred thousand visitors (175,827 admittances counted at entrances).

This largest industrial exposition ever held has received the publicity it so well deserves. One note needs to be emphasized. It is AUTOMATICITY THROUGH INSTRUMENTATION.

In the last five or six years the automatization of machining operations has made more progress than in the preceding five or six decades. One reason is that only in the last five or six years has the Science of Instrumentation been deliberately applied to these *operations*—much in the same manner and by much the same intellectual efforts as it had been applied to *processes* in the last twenty years. Instead of crude triggers, limit stops, etc., actuating clutches, switches, reversing gears, etc., one sees genuine measuring elements commanding prime relays and even scientifically-designed servomechanisms.

In addition to automatization there is an enormous increase in the application of monitoring instruments: of measuring instruments such as ammeters, of integrating instruments such as watt-hour meters, and even of recording instruments, some on the machines themselves, others centralized on panels in superintendents' offices. Which is to say that there has also been progress in the application of totalizing and telemetering instrumentation.

Congratulations to the machine-tool industry.

—MFB

Application of Viscosity Measurement in Petroleum Refining Operations*

By **D. J. POMPEO, Shell Development Company, Emeryville, Calif.**

ABSTRACT. The application of viscosity measurements to the control of petroleum refining operation as applied to lubricating oils, fuel oils, diesel fuels, jet fuels and various types of cut-back asphalt is discussed. Places where automatic recording and control instruments for continuous measurement of viscosity would aid in the control of refinery processes making for more efficient operation are also indicated.

IN the refining of products derived from petroleum one of the important properties requiring close control is the viscosity of the materials to meet specification. Specifically, viscosity measurement applies to such liquids as lubricating oils, fuel oils, diesel fuels, jet fuels, hydraulic oils, certain types of greases, and various types of cut back asphalts used for road construction. Viscosity measurement is a significant factor also in connection with other operations in the winning and handling of petroleum. In the drilling for oil the viscosity of drilling muds is important in determining the performance of circulating fluid in rotary drilling operations; in the pumping of crude oil from the well and also in the transportation by pipe line of the crude, viscosity plays an important role in the efficiency with which the oil is obtained from the ground and the ease with which it can be pumped to its destination for refining operations.

VISCOSITY DEFINED

The absolute dynamic viscosity (η) of a fluid is the tangential force on unit area of either of two parallel planes at unit distance apart when the space between the planes is filled with the fluid in question and one of the planes moves with unit velocity in its own plane relative to that of the other. The viscosity is expressed in dyne-seconds per $cm.^2$ and has the dimensions, ($ML^{-1}T^{-1}$) in the cgs system. The absolute kinematic viscosity (ν) is equal to the quotient of absolute dynamic viscosity by the density of the fluid.

VISCOSITY INDEX

Another important property of a lubricating oil is the viscosity index.[1] This is an empirical number indicating the effect of change in temperature on the viscosity. A low viscosity index signifies a relatively large change in viscosity with temperature; and vice versa. Thus, in a lubricating oil for use in internal combustion engines a desired characteristic is that in cold weather the viscosity is not too high to assure ease in starting and to afford proper lubrication of various parts. Conversely, in hot weather the oil should not be too thin or have too low a viscosity in order to obtain good engine performance.

DETERMINATION OF VISCOSITY IN THE LABORATORY

In a typical refinery control laboratory investigation has shown that approximately 300 determinations of viscosity are made per day (24 hours) in order to control the quality of the various products and to see that specifications are met. Most of the determinations (about 90%) are made on lubricating oils and the remainder (10%) on asphalts, fuel oils and on diesel oils to a lesser degree. From this it is clear that considerable effort and time are spent on this determination alone—aside from other necessary tests, such as flash point, pour point, color and gravity of the various products to meet specifications. Kinematic viscosities are usually determined in the laboratory on lubricating oils and dark oils at temperatures of 100°F., 130°F. and 210°F. using the capillary type instruments; while for the determination of the viscosity of asphaltic type materials, where extreme accuracy is not too important, the Saybolt type of instrument is used at temperatures of 77, 122, 140 and 180°F.

EFFECT OF TEMPERATURE ON VISCOSITY

The accurate control of temperature is an important factor to be considered in the measurement of viscosity. This is true regardless of the type of instrument used; whether it is of the capillary type for kinematic viscosity work, or of the Saybolt type. The effect of temperature on viscosities of various types of oils is illustrated in the data of Table I of Cannon and Heidrich which is reproduced herewith for the reader's convenience.

From the data in Table I it is seen that to obtain an accuracy of 1% in a viscosity measurement for oil A the temperature should be controlled to 0.3°F. in the range of 80-100°F. and to about 0.7°F. for the range of 180 to 210°F. In the case of Oil D, however, temperature must be controlled much more closely (about 0.1 and 0.36°F.) to obtain 1% accuracy for the equivalent temperature range. The accuracy obtainable by the kinematic viscometer, according to the ASTM Method D 445, is of the order of 0.2%; but here the temperature should be controlled to at least 0.05°F. to meet the requirements of this test.

TABLE I—EFFECT OF TEMPERATURE ON VISCOSITY

Oil	———Viscosity in Centistokes at———				Average % change in Vis. per °F. change in Temp.	
	210°F.	180°F.	100°F.	80°F.	100-80	210-180
A	4.36	6.16	24.95	41.9	3.4	1.38
B	4.36	6.48	34.08	64.9	4.5	1.62
C	15.8	25.68	176.3	365.0	5.4	2.1
D	15.8	29.12	362.0	957.0	8.2	2.8

MANUFACTURE OF LUBRICATING OIL

Crude oil as obtained from a well contains the lubricating oil which has to be separated and refined to be of use. The first step in the distillation of crude separates the various component fractions from the lighter to the heavier, such as gasoline, kerosene, fuel oil (gas oil), lubricating oil and the residue asphalt. The lubricating oil fraction is next vacuum distilled to obtain closer boiling components having definite ranges of viscosity.

In a typical refinery distilling of 15,000 bbls. per day as many as five fractions are obtained as indicated in Table II.

TABLE II—VARIOUS FRACTIONS OBTAINED FROM A LUBRICATING OIL DISTILLATION COLUMN

	S.U.S. at 100°F.	S.U.S. at 210°F.	Approx. Temp. °F.
Reflux Cut	67	...	370
Light Cut	246	...	410
Cut 1	...	60	490
Cut 2	...	114	495
Cut 3	...	225	500

A side stream from the various cuts is diverted to a control house where an operator periodically checks the viscos ty with a Saybolt instrument. At this point the measurement of viscosity is an aid to the operator in properly controlling the column. The control laboratory rechecks the samples as obtained from storage tanks before the oil is pumped to the next stage of the refining process.

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*Presented at the Second Annual Conference of the Instrument Society of America, Stevens Hotel, Chicago, Ill., Sept. 8-12, 1947.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

(1) *ASTM Standards on Petroleum Products and Lubricants.* American Society for Testing Materials, 260 Broad Street, Philadelphia, Penna.

(2) *Petroleum Refiner*, Vol. 26, February 1947, page 123.

The lubricating oil fractions so obtained are not suitable as quality lubricants because they contain undesirable components (unsaturated compounds, resins, aromatics and asphalt formers) which produce an oil having a wide variation in viscosity with changes in temperature. One of the methods which is extensively used for removing these undesirable components is solvent refining, with furfural[3] as the extraction agent. Such extraction results in an oil having good viscosity-temperature relationships. Control of the extraction process is accomplished by sending samples to the laboratory and the viscosity is measured at two temperatures (100 and 210°F.) from which the viscosity index is calculated. In this connection it may be mentioned that a measurement of refractive index[4] of the treated oil can be correlated to the viscosity index. However, this measurement depends on the type of crude being processed; thus a change in the crude requires a different value of refractive index to obtain correlation with viscosity index. While refractive-index measurement is an indirect means for determining viscosity index, its measurement has a distinct advantage for plant control, the reason being that the test can be made with an Abbé refractometer by the operator and, if necessary, corrective measures applied without the need of obtaining laboratory results. The latter procedure is time-consuming, especially when the viscosities at two temperatures need to be measured to calculate viscosity index.

Where paraffinic crudes are used, the solvent-refined oil contains enough wax to make it unsuitable for use over a wide temperature range and this must be removed so that the oil will flow freely at low temperatures. In this case the viscosity of oil as well as its pour point is measured as a means of controlling the dewaxing process.

BLENDING REFINERY STOCKS

A number of refinery operations require the blending of various lubricating stocks to viscosity and viscosity index specifications. For example, a light or neutral stock may be blended with a heavy or bright stock to yield a particular grade of motor oil. Blending is done by mixing two or more oils in either kettles, tanks, bleachers, or homogenizers which, with the exception of the latter, are equipped with steam coils for heating, and either air or mechanical mixers for stirring. It is necessary for the control laboratory to determine the viscosity or viscosity index of the blends to ensure proper quality before the material is pumped to drums, cars or storage. In these operations considerable thought is given to automatic blending devices and means for continuous determination of viscosity, as this will reduce the need for expensive storage capacity, aid in better control of the process and decrease labor costs of analysis.

Similarly, it is necessary to blend fuel oil and road oils. A specific example is in the blending of a fuel oil of 800 to 1200 seconds viscosity (Furol at 122°F.) with a lighter fraction to yield a product of 125 seconds viscosity for storage. Blending by means of gravity measurements is not a satisfactory means of control because the viscosity of the material is a limiting factor in meeting specifications.

NEED FOR CONTINUOUS RECORDING VISCOMETERS

In the foregoing discussion it will be noted that no mention is made of either direct-indicating or -recording viscometer instruments for the automatic control of processes. At present, except in a few isolated cases[5] such instruments which can be satisfactorily used in a refinery are practically nonexistent. The impetus given to the development of specialized instruments in the past few years will no doubt change this condition because of the need for improving quality of products and decreasing operating costs. It is well recognized that one way of attaining this objective is the adaptation of automatic-control instruments to the control of a process.

The places where automatic instruments would be useful to the control of process variables are briefly summarized:

1. *At the control house where the lubricating oil fractions are obtained.* At this point an accuracy of 1% to 2% in a determination is probably sufficient for the purpose because the oil requires further processing.

2. *At solvent refining and dewaxing plants.* In this case the measurement of viscosity index is important and the viscosity must be measured quite accurately in order to obtain a good value for the index. Indirect methods, such as continuous measurement of refractive index, may be used to obtain a measure of viscosity index.

3. *At the compound house where the lubricating oil is blended.* Especially would this be important if continuous blending operations were developed because viscosity measurement would be required soon after the mixing took place.

4. *At pump houses where road oils are blended and asphalts are pumped to tank cars, trucks or barges.*

From these considerations it is plain that much work remains to be done in the development of specialized instruments for indicating or recording of viscosity and viscosity index to obtain more efficient control of refinery processes. A knowledge of the process, the variables to be encountered and the accuracies to be achieved in the measurement is essential to produce a workable instrument.

ACKNOWLEDGMENT

Appreciation is expressed to Shell Oil Company, Incorporated for permission to use information regarding certain of their refinery operations and to Messrs. J. G. Kerley and E. F. Tesche for helpful discussions.

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[3] W. E. Skelton, *Oil and Gas Journal*, February 22, 1947, page 137.

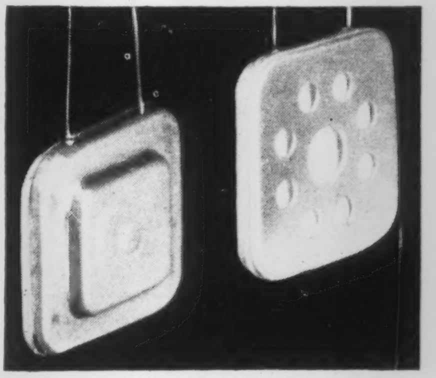
[4] G. H. von Fuchs and A. P. Anderson, *Industrial and Engineering Chemistry*, Vol. 29, March 1937, page 319.

[5] The Fischer and Porter Company, Hatboro, Penna., market a continuous recording viscometer which may have application to certain refinery operations.

INSTRUMENTS ON THE MARCH

(Continued from page 982)

WRIST-WATCH RADIO.—Originally a fantasy in Dick Tracy strips, then realized by the National Bureau of Standards, it depends upon tiny components made by Tibbetts Industries of Camden, Maine, whose "HS-41" square microphone (illustrated) is the world's smallest (1.03" square and 0.21" thick) for its output—49 db-volt/dyne/cm.².



Boston Instrument Society

The Boston Instrument Society held its second dinner-meeting of the season at the Graduate House of M.I.T. on October 29.

President E. R. Hoffman introduced as the after-dinner speaker Secretary Richard Rimbach of the Instrument Society of America, who gave a preview of the 1948 I.S.A. Exhibition to be held in Philadelphia and announced that plans were being considered for an exhibition at Mechanics Hall, Boston, in 1952.

The technical lecture was given by Mr. J. M. Devine of the Baird Associates, Cambridge, Mass., who spoke on Infrared Spectrometry, its principles and its applications.

The next meeting will be held Wednesday, December 3 at the Colonial Beacon Oil Refinery, Everett, Mass.

—J. H. CONDON

Control of Narrow-boiling-range Fractionating Columns*

By G. G. GALLAGHER, Universal Oil Products Co., Chicago, Illinois

PRESENT-DAY petroleum refining practices are working toward a higher and higher degree of separation of the narrow-boiling-range hydrocarbons; hence more accurate and more direct methods of instrumentation and control are required.

The usual means of temperature and pressure control, long used on ordinary fractionating columns, are not adequate for the super fractionators now in service.

Fig. 1 shows a deisobutanizing column which fractionates isobutane from normal butane.

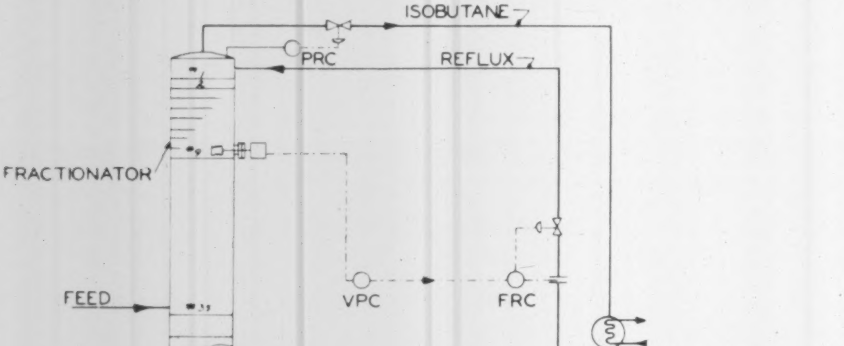


Fig. 1. Deisobutanizing column which fractionates isobutane from normal butane.

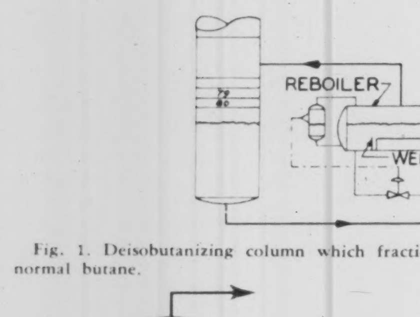


Fig. 2. Vapor-pressure balance.

At 110 lbs./in^2 column pressure, there is only 23°F. difference between the boiling point of pure isobutane and that of pure normal butane. On this basis a change of only 1°F. in column temperature will cause a change in composition of approximately 4%. From this it can be seen that the accuracy required is hardly possible with present-day temperature controllers. Even then, holding the temperature alone constant will not suffice since the purity of the product overhead may also vary in the order of 2% to 3% with a change in pressure as small as 1.0 lb./in.^{2}. Changes in barometric pressure alone can be responsible for variations of several per cent in the purity of the overhead material. From this it can be seen that it is important to maintain *both* pressure and temperature within exceptionally close limits. Since temperature and pressure controllers with the required accuracy were not available, a search was made for a better method of control. What was most desired was a composition controller that would make the necessary adjustments to the process for variation in column temperature, pressure, feed composition or feed quantity.

One method which has been developed for controlling such narrow-boiling-range columns is commonly known as a vapor-pressure controller, although on strictly *binary* columns it is essentially a *composition controller*. This instrument consists of a temperature bulb and pressure connection, both being located at the same point in the column (Figs. 2 and 3). The temperature bulb is partly filled with one of the materials being fractionated. This bulb, when exposed to the column temperature, will exert a vapor pressure against one side of the diaphragm or mercury U-tube, the other side of which is opposed by the pressure of the column taken at the same point that the temperature-sensitive bulb is located. Whenever the material at this point in the column is of the same composition of that in the bulb, no differential on the instrument will exist regardless of what pressure or temperature elevation is encountered. Conversely, by holding a zero differential pressure on the vapor-pressure controller, the composition on the tray will always be the same as that in the bulb.

By looking at curves on Fig. 4 it can be seen that, with a constant differential on the vapor-pressure controller,

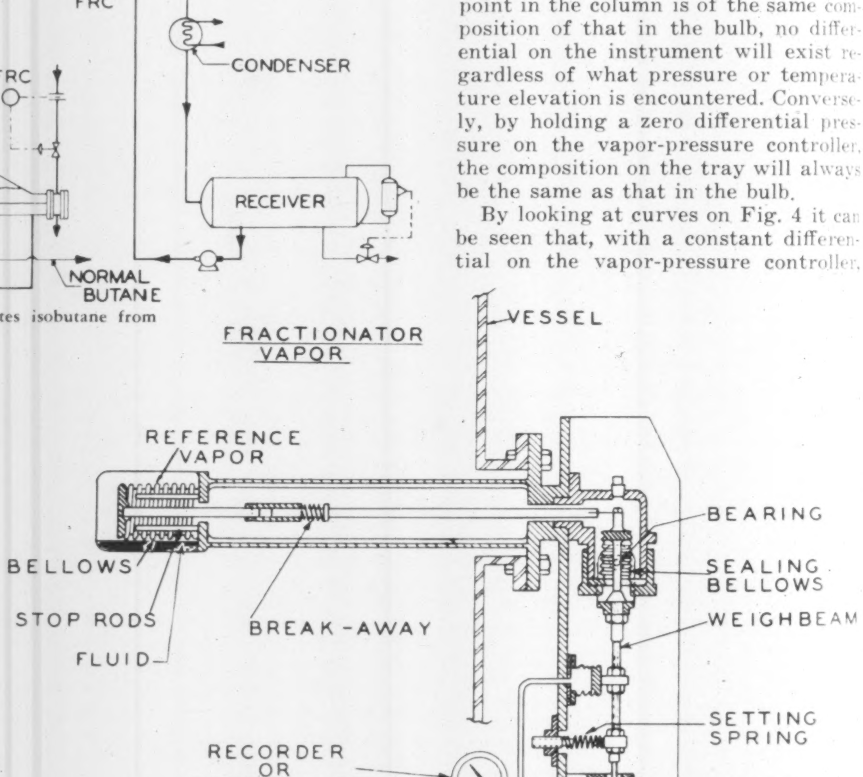


Fig. 3. A vapor-pressure transmitter.

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*Presented before the Chicago Section of the Instrument Society of America, February 3, 1947.

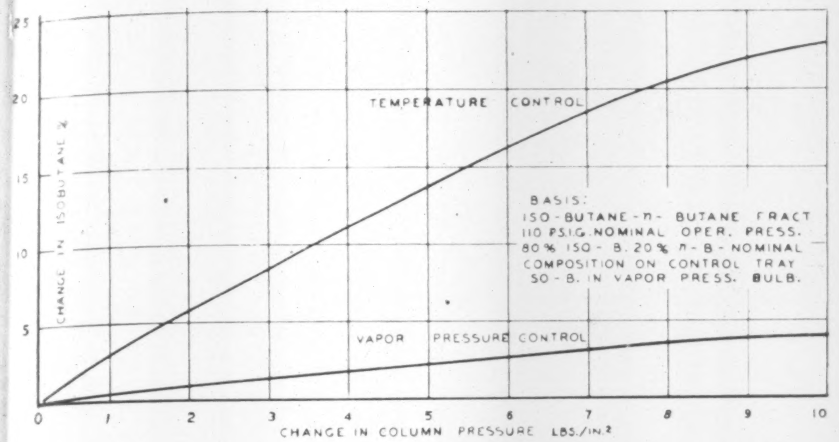


Fig. 4. Composition change on control tray vs. column pressure deviation for binary column using vapor-pressure controller or temperature controller.

little change in composition is encountered even with wide changes in column pressure. In other words, with a 1-lb. change in column pressure, the composition will only change 0.4% instead of the 2% to 3% encountered when using a temperature controller and assuming it holds the temperature perfect. Therefore, it may be said that this instrument can control composition within extremely close limits by controlling the differential pressure between the column and the bulb.

Although this method of control is satisfactory for binary columns, its use in columns of multi-component mixtures is somewhat limited and the limitations have not as yet been fully explored.

The petroleum and chemical industries have developed needs for new and revolutionary types of instruments faster than the instrument industry was geared to keep in step. Several years after development of the need for a better means of controlling the multi-component columns, undesirable indirect methods of control are still being used because a satisfactory direct composition controller was unavailable. This is a definite challenge to the instrument industry to intensify its research and development along these lines.

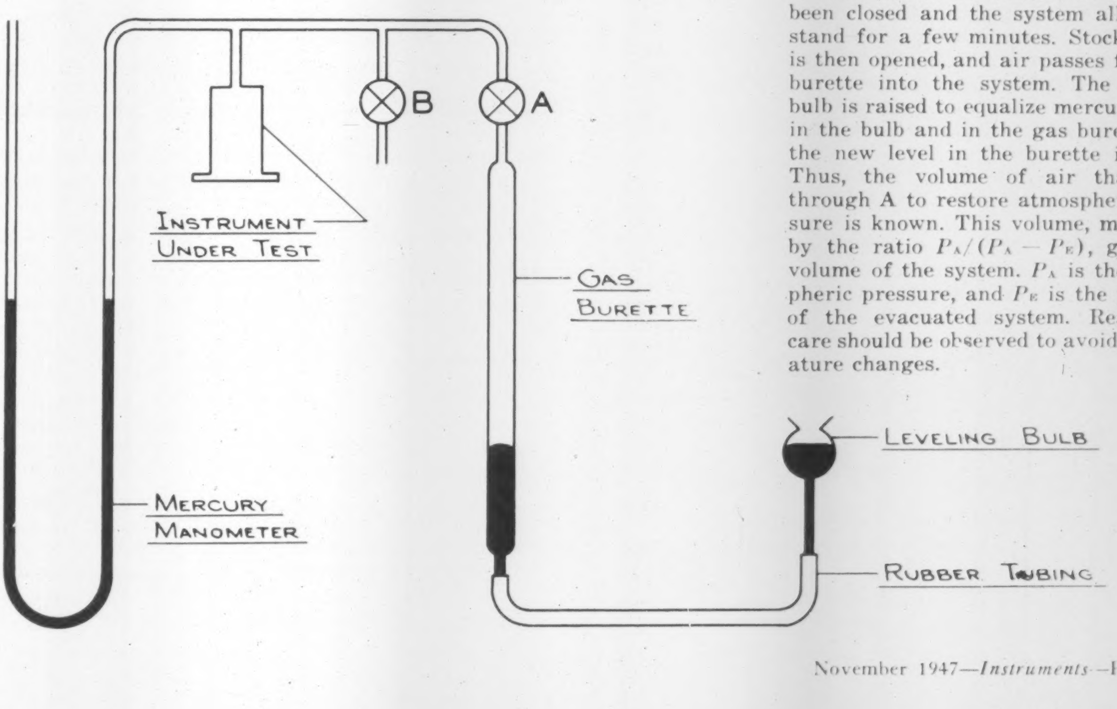
The Use of Air as a Volume-measuring Fluid

By NATHAN KAPLAN, Research Chemist, Kollsman Instrument Div., Square D Co., Elmhurst, N. Y.

IN conjunction with the testing of aircraft instruments it is occasionally desirable to know the free air volume inside the instrument. This is simply the difference between the total internal volume of the case and the volume occupied by the mechanism. This can be determined by measuring the volume of a liquid needed to fill the instrument. However, if this instrument is to be used after having been subjected to such treatment, it is necessary to remove all traces of the liquid. Actually, in order to prevent any malfunctioning due to residual liquid, such instruments have been cleaned by completely disassembling the mechanism, carefully cleaning the parts, and reassembling the instrument. Even if a highly volatile liquid were used, disassembly would probably be necessary to insure complete removal of liquid.

In order to eliminate this laborious cleaning process, it was decided to use air as the volume-measuring fluid. Briefly, this is done as follows: The instrument is evacuated to a known pressure below atmospheric, and then atmospheric pressure is restored by admitting air to the instrument from a gas burette. From a knowledge of the volume of air admitted, the atmospheric pressure, and the pressure after partial evacuation, the free-air volume of the entire system can be calculated. The volume of the external lines (easily determined with water) is subtracted to give the free air volume of the instrument.

The sketch shows the system used. With stop-cock A open, and B open to the atmosphere, the system is at atmospheric pressure. The mercury level in the gas burette is adjusted so that it is near the low end, and the level is noted. Stop-cock A is then closed, and the system is partly evacuated through B to some arbitrarily chosen pressure, which is read on the manometer after B has been closed and the system allowed to stand for a few minutes. Stock-cock A is then opened, and air passes from the burette into the system. The leveling bulb is raised to equalize mercury levels in the bulb and in the gas burette, and the new level in the burette is noted. Thus, the volume of air that went through A to restore atmospheric pressure is known. This volume, multiplied by the ratio $P_A/(P_A - P_E)$, gives the volume of the system. P_A is the atmospheric pressure, and P_E is the pressure of the evacuated system. Reasonable care should be observed to avoid temperature changes.



A Simplified Warm Hardness Test for Temperatures Below 700°F.

By A. L. PRANSES, Metallurgical Engineer, Materials Engineering Dep't, Westinghouse Electric Corp., East Pittsburgh, Pa.

IT recently became desirable to determine the hardness of various steels at temperatures intermediate between room temperature and the lower critical. Such measurements were needed as preliminary data before exploring the warm hubbing field. (The term "warm" in this report refers to subcritical temperatures for steel.) At the same time, it was not desired to construct an elaborate apparatus since only a few tests were contemplated. After some consideration, the apparatus shown in Fig. 1 was devised. It makes use of equipment available in any metallographic laboratory and requires an absolute minimum of set-up time. Details of its construction and use are given below to enable other investigators to use it should the need for warm hardness measurements arise.

The equipment needed is listed below:

1. Rockwell hardness testing machine[1] with Rockwell "B" indenter and flat anvil.
2. Heating unit from metallographic mounting press.
3. Heavy leather or asbestos gloves.
4. A wire brush.
5. "Tempilstiks"[2] in increments of 50°F. from 150°F. to 750°F.
6. A flat plate ground on both sides. (Refractory metal is preferred and "Refractaloy 70" was used for the tests described herein; however, any hardened steel plate possessing low thermal conductivity and resistance to softening at testing temperatures should suffice.)
7. Knife or razor blades.
8. A cylindrical sample of material to be tested, machined to just slide into the heating unit and about one-half inch longer than the height of the heating unit. Grind the testing surface.

The following is the testing procedure used:

1. Determine room temperature and room temperature hardness, then adjust distance between the indenter and anvil so that the assembly shown in Fig. 1 may be put into place readily—leaving only a short distance between the top of the specimen and the indenter.
2. With the assembly on a metal block or sheet of insulating material on the work table adjacent to the Rockwell machine, scrape several powder size particles of the 150°F. "Tempilstik" on the testing surface, then plug in the heating unit cord.
3. As soon as the particles of "Tempilstik" begin to fuse, clean off the testing surface with the wire brush, slide the assembly on top of the testing machine anvil, and take two or three readings.
4. Remove the assembly to its position beside the testing machine, put several particles of the 200°F. "Tempilstik" on the testing surface, then repeat the above procedures at desired temperature intervals until the desired or maximum temperature has been reached. It was found experimentally that, using the heating unit available to the writer,[3] temperatures above 700°F. could not be obtained.

Certain testing precautions should be observed. They are as follows:

1. Check the Rockwell "B" indenter on a test block both before and after running the warm hardness test. The latter test will indicate if the ball indenter has been tem-

Continued on page 1066

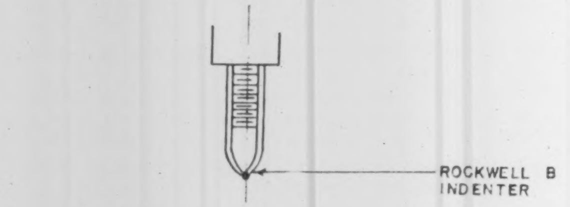


Fig. 1

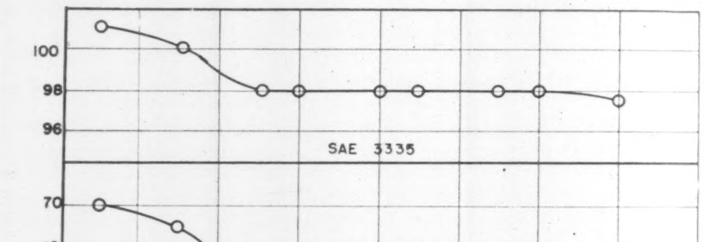


Fig. 2

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[1] Manufactured by the Wilson Mechanical Instrument Co., Inc., New York, N. Y.

[2] Manufactured by the Tempil Corp., New York, N. Y.

[3] A 1½" ID, 110-volt a-c. unit manufactured by the Adolph Buehler Co., Chicago, Ill.

Scientific Glass Blowing and Laboratory Techniques

By **WILLIAM E. BARR** and **VICTOR J. ANHORN**, Gulf Research & Development Company

XV. DESIGN AND CONSTRUCTION OF DISTILLATION EQUIPMENT

(Continued)

THE DISTILLATION COLUMN

(Continued)

Methods of Making Columns Adiabatic

The problem of making a small laboratory fractionating column adiabatic is one that does not lend itself to an easy solution. If compounds with greatly different boiling points are fractionated, a large temperature gradient is obtained between the bottom and the top of the column. On the other hand, if compounds with close boiling points are to be fractionated, the temperature gradient will be quite small. Usually a fractionating column is designed for one specific mixture. However, a great deal of flexibility is desired and often required. Consequently, columns for general use should at least approach adiabatic conditions under such operations. To obtain such conditions, heat must be supplied to small laboratory columns. Electrical heaters can be arranged to give approximate adiabatic conditions.

The vacuum-jacketed column which is silvered or contains a radiation shield,[5] probably is the most effective method of making an adiabatic laboratory fractionating column. However, even with a vacuum column, some heat is lost especially if compounds are distilled which have boiling points in the range 150 to 250°C. To minimize this heat loss an electrical heater can be wound around the outer jacket. Such an arrangement is illustrated in Fig. 190B.

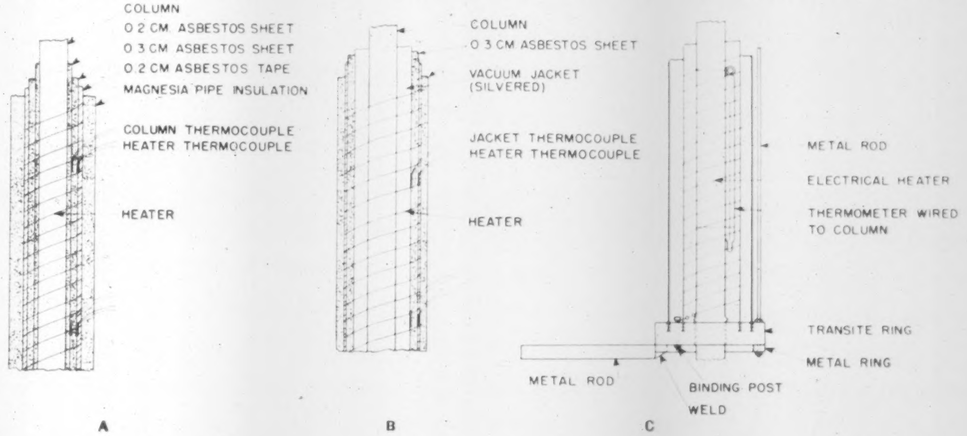


Fig. 190

Thermocouples are fastened to the outside of the vacuum jacket by covering them with a thin copper sheet and wiring this sheet to the jacket. The thermocouples should be spaced along the length of the jacket, especially if more than one column heater is used. A layer of asbestos sheet or tape is wrapped over the jacket to a thickness of about 0.3 cm. A second set of thermocouples is fastened directly over the first set by the procedure outlined for the first set. A double layer of asbestos tape or thin asbestos paper is wrapped on the column over the thermocouples. A suitable resistance heater is then wound on the covered jacket. If a large temperature gradient is expected when the column is in operation, the heater windings on the jacket can be spaced so that more heat is supplied to the bottom section. An alternative is to use two or more separate heaters along the length of the column. The heater is covered with a 0.3 layer of asbestos paper or tape.

The thermocouples, one next to the jacket, and the second under the heater, are used to indicate whether that portion of the column is operating under adiabatic conditions. If both indicate the same temperature, there is no lateral heat flow.

It is sometimes necessary to use the insulation, thermocouples and electrical heater directly on the column. This method is illustrated in Fig. 190A. The arrangement of thermocouples, lagging and heater is similar to that of the vacuum jacketed column except that the column is first wrapped with asbestos paper or tape and magnesia pipe insulation is used as the final covering.

A third method, frequently used, is illustrated in Fig. 190C. This arrangement is advantageous when complete visibility is desirable. The column is surrounded with an air space. Thermometers or thermocouples are wired to the column. The heater tube should be large enough so it can be slipped over the column. Small holes at each end of the tube are used to anchor the heater. Three lengths of asbestos cord, ⅛″ in diameter, extend along the entire length of this tube. The electrical heater is wound on the heater tube over these cords. The third tube is used to protect the heater. The two tubes and column are held in place by transite rings. Binding posts and metal column supports are fastened to these rings. Small rods hold the two end rings together.

The arrangement of a staggered dual heating element has been suggested by F. Todd.[6] The top and bottom heaters extend the entire length of the jacketed space around the column and overlap at the middle third of the jacket. The upper and lower heaters are separated from each other by porcelain rings. Springs in these rings keep the heaters from sagging when the heater wires expand.

The choice and arrangement which is adopted for making a column adiabatic will depend on the facilities available. Vacuum-jacketed columns can be made in a good glass-blowing shop, but will require time for construction, silvering and evacuation. Voltage controllers are required for electrical heaters. Each addition of equipment for better control naturally complicates the distillation equipment. A complete study of what is required to do the job in the simplest way is always helpful before the equipment is assembled.

Laboratory Column Packings

The function of the packing in a fractionating column is to provide a medium for intimate contact between ascending vapors and the descending liquid or reflux. The packing should not materially reduce the throughput or capacity of the column. To facilitate contact of vapor and liquid, the packing should have a large surface area and at the same time have a high void space to allow vapor to move through the fractionating section.

Since packing is used to favor intimate contact of liquid and vapor, some means must be available to determine its efficiency. This efficiency is rated as the height equivalent to a theoretical plate or the height of the column in which the vapor in the column contacts the liquids so completely that equilibrium is established between the vapor and liquid. This height equivalent to a theoretical plate, H.E.T.P., is the basis upon which packings have been compared to date. Furthermore, the H.E.T.P. is an important factor when close boiling compounds are to be separated by fractionation.

The procedure in determining the H.E.T.P. of a packing is to operate the column under idealized conditions, i.e., total reflux, and at several different reflux rates. The column is first flooded and then allowed to operate under each of these conditions until equilibrium is established. Data from the analysis of the distillate and stillpot liquid are used to calculate the theoretical plates of the column. Data obtained under these idealized conditions are helpful mainly as a comparison of various packings. The reader is warned not to extrapolate data obtained at total reflux to operations at finite reflux ratios. Erroneous conclusions are often obtained by such procedures. It does follow, however, in the majority of cases, that packed columns which have a large number of theoretical plates under ideal operations are more efficient under operation of finite reflux ratios, than packed columns that exhibited fewer theoretical plates under total reflux.

To insure proper separation at finite reflux ratios, it is best to test the column under the desired operating conditions. F. C. Collins and V. Lantz[7] have used such a procedure in their evaluation of the Oldershaw glass bubble plate column. It would be helpful if data as given by Collins and Lantz were available for all laboratory packing. Such data would reveal packing performance which would more nearly approach conditions used in the laboratory. Manufacturers of packings are eager to sell theoretical plates and consequently submit data which shown the smallest H.E.T.P. for their packing.

Selection of Packing for Laboratory Columns

Four factors must be considered when packing is selected for laboratory fractionating columns. These factors are as follows:

1. *The Height Equivalent to a Theoretical Plate.*

The choice of the H.E.T.P. will depend on the separation that is desired. The cost of very efficient packing (small H.E.T.P.) is considerably more than for less efficient packing. Consequently, if a low H.E.T.P. is not required, a considerable saving can be effected by choosing the less expensive packing. The available height for the column sometimes requires that a more efficient packing be used.

2. *The Pressure Drop Through the Packing*

The pressure drop through a packing must be considered when the fractionating column is to be used under reduced pressure. Since reduced pressure is employed to lower the boiling temperature of components in a mixture, it is essential to have a low pressure drop through the packing. Temperatures in the stillpot will not correspond to the recorded values which can be obtained under the reduced pressure at the top of the column.

3. *The Maximum Rate Without Flooding*

The maximum counterflow rate of vapor and liquid in a column, i.e., rate of flow just short of the flood point, determines throughput of the fractionating column. This rate should be large enough to be practical and yet not decrease the H.E.T.P. If time is not a factor in fractionations, low throughput rates can be tolerated provided the desirable H.E.T.P. can be obtained under such operating conditions. Some packing material exhibits changes in H.E.P.T. as the throughput is increased. These factors must be balanced against each other if a choice of packing is made.

4. *The Liquid Hold-up on the Packing*

If sharp separations are desired in fractionating a mixture, the operating hold-up must be small. The most important effect of hold-up is in its relation to the amount of the charge and the amounts of components in the mixture. More efficient fractionation can be obtained when the hold-up is small because more surface is employed to rectify one component in the charge. The development of efficient column packing has favored columns with low hold-up because shorter columns can be used.

A factor which is not related to the geometric design but which is very important, especially if a fractionating column is used as an all-purpose column, is to have packing which resists corrosion. Corrosive materials can then be fractionated. Of greater importance is the ease by which columns can be cleaned. Fouled packing cannot be expected to operate satisfactorily because the contacting efficiency is decreased. If the packing is resistant to corrosion, a cleaning solution (concentrated sulphuric acid and sodium dichromate) can be used. A *rapid* water wash of the packing is recommended after the packing is cleaned with the acid solution. Columns containing stainless steel carding teeth have been cleaned in this manner may times in this laboratory.

Many types and forms of packing as well as methods for effecting fractionation have been used. Considerable data can be collected from the literature concerning the H.E.T.P. of packing at different reflux rates. The trend has been toward the ideal packing, i.e., low hold-up, high capacity and low H.E.T.P. The H.E.T.P. and throughput data of some column packing recorded in the literature are given in Table 24. The column packings are divided into the following groups:

1. No packing.
2. Dump-in types.
3. Geometric types.

The data in Table 24 should be taken as a guide for the adoption of column packing. If any single packing is desirable, reference should be made to the original publication for a more complete discussion.

CONDENSERS

Since reflux is required in the operation of a fractionating column, some means must be provided for dividing vapors or condensed vapors which issue from the rectifying section. Numerous ways and methods have been tested and reported in the literature. Each of these column heads can be divided into two distinct types, the partial and total condenser stillheads. The former type, although used in some laboratories, does not have the popularity of the total condenser. It is more difficult to control the reflux ratio with a partial condenser. The total condenser, where the vapor or liquid is divided into reflux and product, is almost entirely used on small laboratory columns. The following discussion will be concerned only with total condensers.

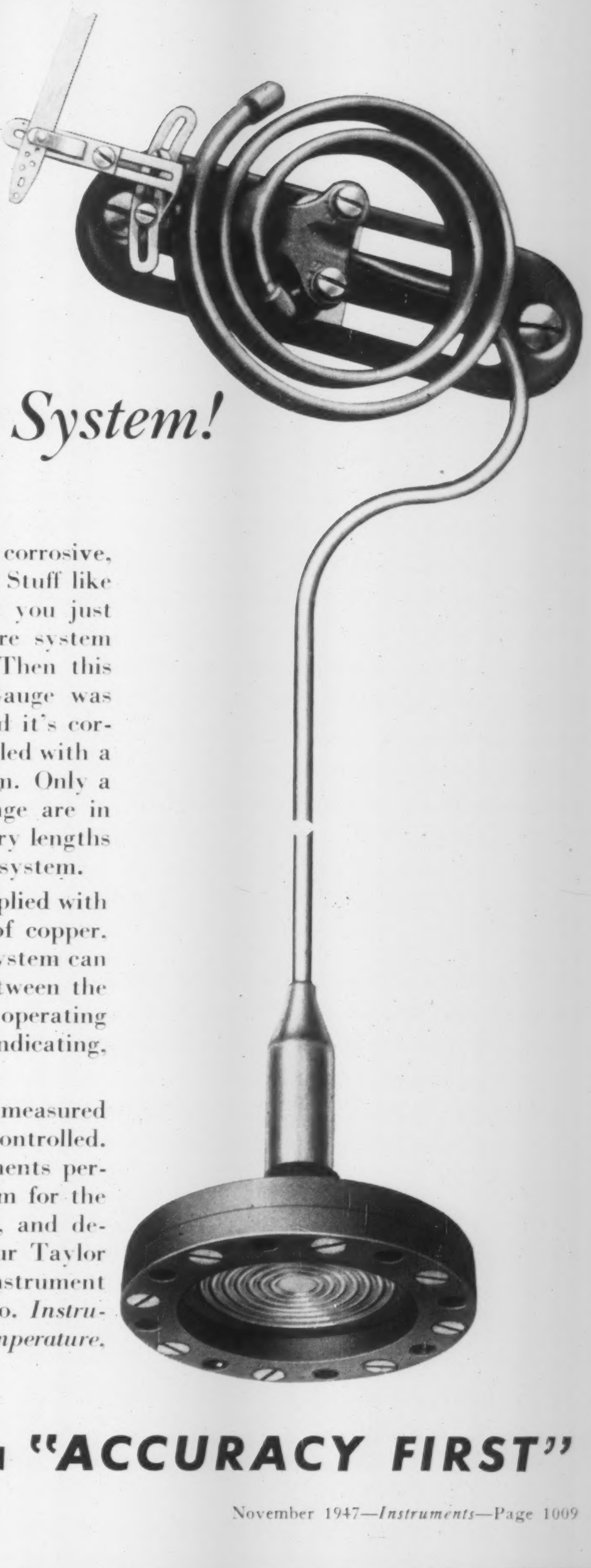
The design of the stillhead should be simple. If the column is used in routine analysis, it is desirable to have simple stillheads which can be quickly and easily repaired when breakage occurs. Of greater importance in the design of the stillhead is a low hold-up capacity. The hold-up of the packing usually is high enough that considerable hold-up in the head cannot be tolerated. Another minor factor in the design of stillheads is that the vapor volume or void space between the packing and cold condenser should not be large.

The methods by which the overhead liquid or vapor stream is divided into reflux and product are as follows:

1. Manual operation of stopcock or tapered plugs.
2. An electrical cycle timer which operates a solenoid valve in the stillhead. Liquid or vapor is intermittently removed as the distillate product.
3. The use of a constant reflux ratio distilling head (Corad head).

The manual control of the reflux ratio is very tedious and unless low reflux ratios are used, it is impossible to estimate them. There is, however, a definite advantage in using manual control, especially in laboratories where other facilities are not available. A common type of stillhead in which the reflux ratio is regulated with a stopcock is shown on the fractionating column in Fig. 206. The two drop counters, one in the product line and the other in the liquid reflux line, can be used for setting the reflux. A second stillhead for manual control is shown on the column in Fig. 207. A third stillhead arrangement is shown in Fig.

ALL GUMMED UP?



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TAYLOR INSTRUMENTS MEAN "ACCURACY FIRST"

TABLE 24

LABORATORY COLUMN PACKING

Type of Packing	*Reference*	*Operation*	*Length of Column, Cm.*	*Diam. of Col. Cm.*	*Reflux Rate cc/hr.*	*H.E.P.T. cm.*	*H.E.P.T. in.*	*Test Mixture*
1 No packing	8	Total Reflux	128	0.415	250	16	6.3	n-heptane-methyl cyclohexane
	9	Total Reflux	68.5	1.9				Benzene-carbon tetrachloride
	10	Total Reflux	30.3	0.3	36	3.36	1.32	Benzene-carbon tetrachloride
					180	30.3	11.9	Benzene-carbon tetrachloride
	11	Total Reflux	290	5.1	2900	65	25.5	n-heptane-methyl cyclohexane
2 Dump-in Types								
Glass balls 2.95 mm.	12 13	Total Reflux	140	2.58	900	4.2	1.65	Benzene-ethylene chloride
Berl Saddles 4 × 4 mm.	14	Total Reflux	68.6	1.9		3.2	1.25	n-heptane-methyl cyclohexane
7/32" Carding Teeth	9	Total Reflux	107	1.4	3800	9.5	3.7	n-heptane-toluene
Carding Teeth	9		168	2.03	1500	7.62	3.0	Benzene-carbon tetrachloride
5/16" Carding Teeth	10	Total Reflux	30.3	0.6	216	9.3	3.6	Benzene-carbon tetrachloride
1/8" × 7/32" Carding Teeth	11	Total Reflux	290	5.1	14700	6.4	2.5	n-heptane-methyl cyclohexane
					4600	5.1	2.0	
1/8" Carding Teeth	15	Total Reflux	150	3.15	4600	5.1	2.0	Benzene-ethylene chloride
					14800	8.9	3.5	
4 × 6 mm. Carding Teeth	16	Total Reflux	274	3.2	1800	7.4	2.9	n-heptane-methyl cyclohexane
					2100	5.6	2.2	
					5000	7.9	3.1	
Chain								
No. 19 Al Jack Chains		Total Reflux	150	3.15	3700	10.7	4.2	Benzene-ethylene chloride
					14000	13.7	5.4	Benzene-ethylene chloride
Locket Chains 33	12	Total Reflux	140	2.58	1290	3.5	1.3	Benzene-ethylene chloride
Comminuted Materials	15	Total Reflux	150	3.15	2200	5.1	2.0	Benzene-ethylene chloride
					3700	4.6	1.8	
Glass Helices								
3 mm. I.D.	17	Total Reflux	320	0.8	6	4.1	1.6	Benzene-ethylene dichloride
3.2 mm. I.D.	18	Total Reflux	44	1.4		4.57	1.8	Benzene-carbon tetrachloride
Metal Helices								
4 mm. I.D. Ni Single Turn	11	Total Reflux	290	5.1	15800	7.9	3.1	n-heptane-methyl cyclohexane
0.094" Steel Single Turn Helices	15		150	3.15	4700	5.1	2.0	Benzene-ethylene chloride
					11000	5.6	2.2	
3 mm. Single Turn	19	Total Reflux	1250	3.3	2500	13.5	5.3	n-heptane-methyl cyclohexane
					4200	10.4	4.1	n-heptane-methyl cyclohexane
3/32" Single Turn Stainless Steel	19	Total Reflux	290	5.1	7400	5.8	2.3	
					2000	3.8	1.5	n-heptane-methyl cyclohexane
3/32" Single Turn from 30 B. and S. wire	20	Total Reflux	60	2.0	900	2.7	1.06	n-heptane-methyl cyclohexane
					1260	2.8	1.1	n-heptane-methyl cyclohexane
Rashig Rings Stoneware 1.27 × 1.27 mm.	11	Total Reflux	290	5.1	17000	15.2	6.0	n-heptane-methyl cyclohexane
					8660	19.1	7.5	n-heptane-methyl cyclohexane
3 Geometric Forms								
Concentric Tubes (center tube wrapped with glass thread)	21	Total Reflux	238	1.3	75	2.2	0.87	n-heptane-methyl cyclohexane
					300	5.6	2.2	
Heli-Grid, 13 mm.	22	Total Reflux	91.5	1.3	375	5.5	2.2	n-heptane-methyl cyclohexane
					550	4.0	1.56	
Heli-Grid, 25 mm.	32	Total Reflux	91.5	2.5	500	1.0	0.39	n-heptane-methyl cyclohexane
					1000	1.26	0.495	
					1500	1.57	0.62	
Plates (Bubble Cap)	23	Total Reflux	40	2.5	288	7.2	2.8	Benzene-carbon tetrachloride
					1242	8.2	3.2	
	24	Total Reflux	200	2.5	480	2.3	0.9	Benzene-carbon tetrachloride
					600	2.7	1.06	
Perforated Plates	25	Total Reflux	45	3.2	1020	2.9	1.14	Benzene-carbon tetrachloride
					4500	4.5	1.76	
Spinning Band								
6 mm. Monel Band	26	Total Reflux	545	0.67	162	8.0	3.1	n-heptane-methyl cyclohexane
Rotating Cones	27		56	5.08	108	8.7	3.4	n-heptane-methyl cyclohexane
Spirals					282	9.5	3.7	
Square Threads on Monel Rod	28	Total Reflux	320	2.5	90	2.7	1.05	n-heptane-methyl cyclohexane
					400	3.4	1.35	
					600	3.8	1.54	
Wire Gage								
Stedman 105	29	Total Reflux	61	0.95	100	6.6	2.6	Benzene-ethylene dichloride
					200	14.5	5.7	
Stedman 104	29	Total Reflux	61	1.9	150	6.8	2.7	Benzene-ethylene dichloride
					500	46.9	18.5	
					900	61.0	24.0	
Stedman 112	29		61	2.5	150	4.8	1.8	Benzene-ethylene dichloride
					500	35.8	14.1	
					900	38.1	15.0	Benzene-ethylene dichloride
Spiral Screen	30	Total Reflux	43	1.9	100	1.7	0.67	n-heptane-methyl cyclohexane
					300	1.7	0.67	
					500	1.76	0.68	
					700	2.26	0.90	
			43	1.3	100	1.7	0.67	
					300	1.7	0.67	
					400	1.87	0.74	

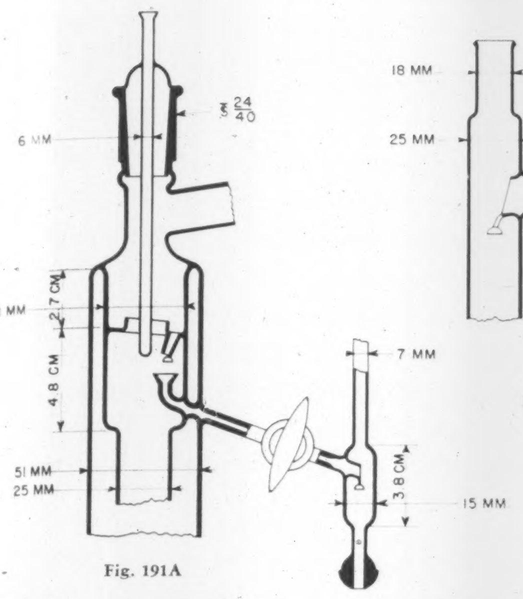

Fig. 191A

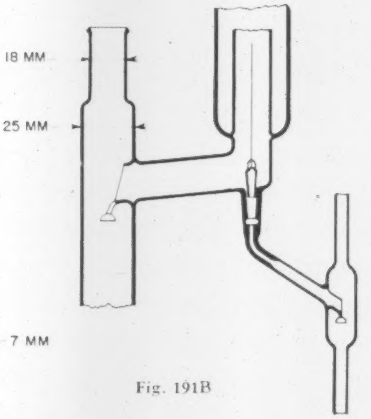

Fig. 191B

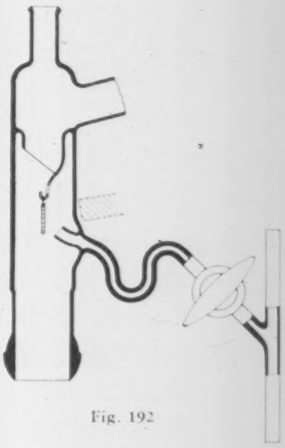

Fig. 192

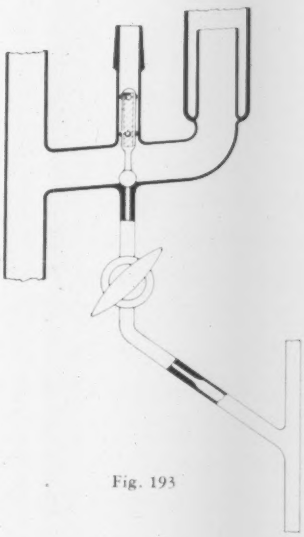

Fig. 193

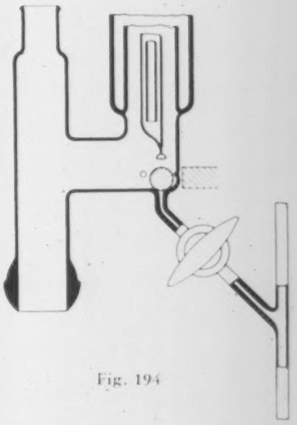

Fig. 194

191A. This head is recommended when fractionations are performed at reduced pressure. Condensation of vapors of high boiling materials need not take place in the water-cooled condenser which is attached to the top side arm. All condensate outside of the vacumn jacket is returned to the small cup. The reflux is adjusted with a stopcock according to the drops which leave the glass alembic and product drop counters. It is sometimes convenient to slot the plug of the stopcock so the smaller flows can be obtained. This is accomplished by filling a small groove on opposite sides of the bore opening with a three-cornered file. These slots should be 1/16" long.

A fourth method of manual adjustment of the reflux ratio was recommended by F. D. Rossini.[31] A portion of the head is illustrated in Fig. 191B. The glass plug can be raised or lowered by a hand screw which has small threads. This handscrew is held in place by a housing which can be made leak proof by using a bellows.[31] The glass plug is sealed to a tungsten rod. The arrangement of obtaining the reflux ratio is by counting the drops at the reflux and product drop counters.

The effect of constant versus intermittent product withdrawal from fractionating columns has not been extensively studied. It has been assumed that constant removal of product was the best way to operate columns. D. M. Oldroyd and L. A. Goldblatt[32] have shown that when efficient packing is used (Podbielniak Heli-Grid packing) more efficient separation can be expected with intermittent product removal. Less efficient packing as 3/16" Fenske-type glass helices and a Palkin type gauze plate column did not show such a pronounced advantage as the Heli-Grid packing. If efficient packing is available, it is desirable to use stillheads which permit intermittent product removal. Stillheads which can be operated at intermittent take off require solenoid valve arrangements. The following discussion will cover a few such stillheads.

The stillhead of the Podbielniak Hyper-Cal fractionating column is shown in the column assembly in Fig. 203. An Inconel ball seats in a ground glass recess. This ball is attached to a magnetic armature by a hollow Inconel tube which has a vent at the top. A solenoid coil is located above the dual U-tube condenser. The drippers on the condenser tip are so arranged that the condensate is directed on the Inconel stem and ball. The valve is operated by a cycle timer. Valve travel can be adjusted by the screw above the solenoid coil. The entire condenser is housed in the vacuum jacket. The void space between the top of the Heli-Grid packing and the tips of the condenser is quite small. The hold-up of the head is small. The vapor temperature is determined by a thermocouple.

The stillhead similar to the one shown in Fig. 192 was used by E. A. Naragon and C. J. Lewis[33] on a vacuum column. The solenoid coil is placed over the center tube containing the glass valve. The ground joint facilitates removing the movable glass valve and cleaning of the valve seat. This joint is covered with the cap of the second member of the joint after the solenoid coil is in place. The stopcock need not be used while the column is in operation.

The stillhead in Fig. 193 contains a steel ball which is lifted slightly when the iron core is magnetized. This steel ball is held in place by two indentations on both sides of the reflux tube. These indentations are shown as small rings to the left of the ball. The finger condenser in this assembly has a drop counter.

The stillhead which is illustrated on the continuous fractionating column, Fig. 208, is another example of a glass solenoid valve. All reflux from the total condenser flows through the valve back into the column. Part or all of this liquid stream is diverted to the distillate product receiver when the solenoid coil lifts the glass covered iron core. This arrangement of outside return line and take off valve has the disadvantage of having a greater hold-up than is obtained in the stillheads described above. In continuous fractionation this hold-up is not too serious because the reflux is of a constant composition.

The vapor dividing stillhead described by F. C. Collins and V. Lantz[7] operates on the solenoid ball valve principle. The vapor from the column is directed either into a Dewar-jacketed total reflux condenser or to the product condenser. The glass ball is lifted by a solenoid coil. The temperature is obtained by a partial-immersion thermometer. The stillhead is Dewar-jacketed. The reflux condenser and ball of the valve can be removed because the standard taper assembly fits into the joint in the stillhead.

J. D. Bartleson, A. L. Conrad and P. S. Fay[34] have described a stillhead with the valve arrangement consisting

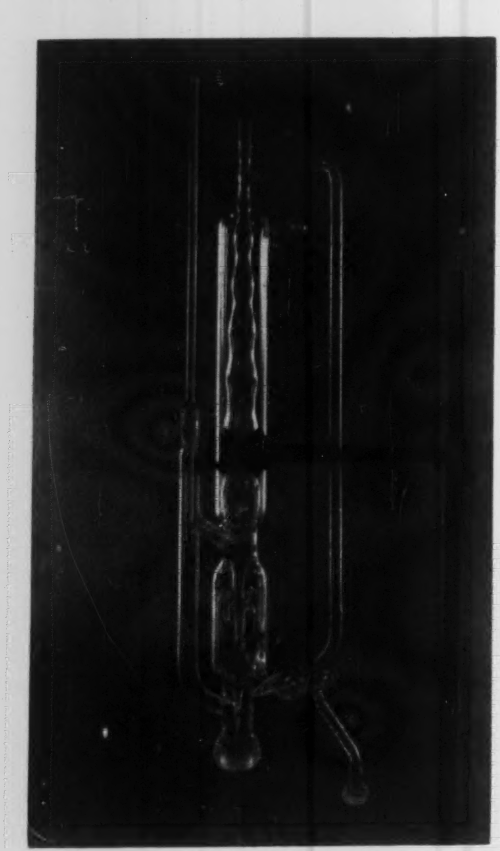

Fig. 195

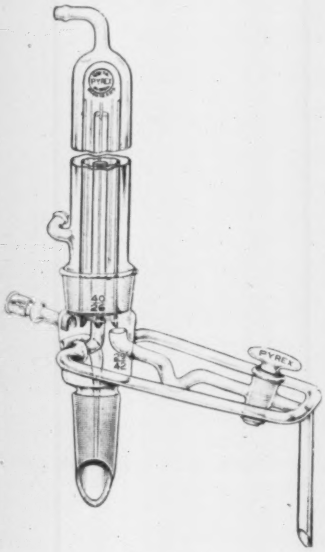

Fig. 196

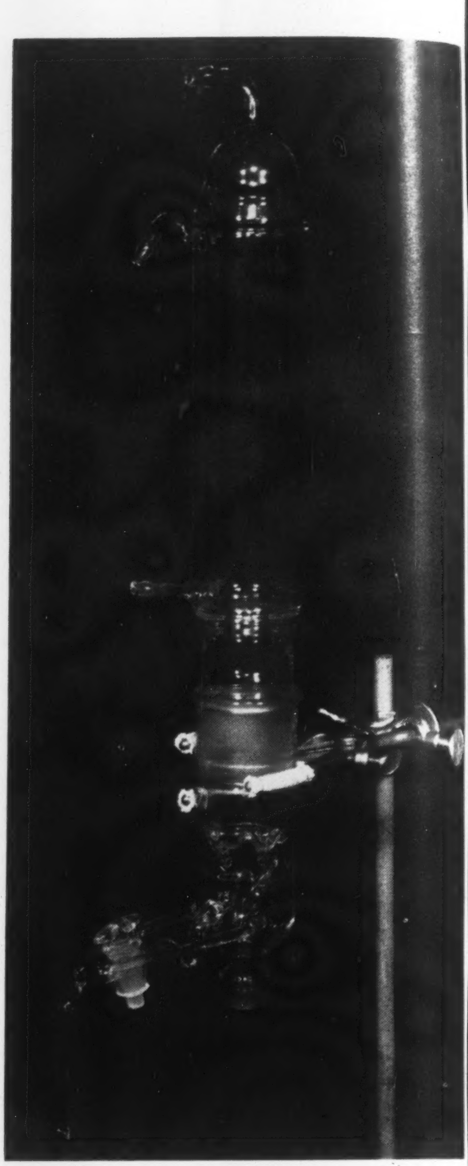

Fig. 197

of a glass covered steel ball in a funnel. This funnel containing the ground surface is located directly under a liquid directing funnel and below the total condenser. Product is removed by magnetizing an iron core in a solenoid coil. The ball is drawn partly out of the funnel allowing liquid to flow into a product receiver.

The solenoid operated valves described above must be clean. Probably the greatest fault of these valves is the fact that liquid will leak through them if the surfaces are not perfectly ground and clean.

Another type of stillhead which is operated by a cycle timer is shown in Fig. 194. H. J. Hepp and D. E. Smith[35] have used this stillhead on a precision fractionating column. This type of head differs from the ball valve heads in that the reflux liquid is directed to the product cup. A solenoid coil around an iron core is used to swing the iron wire against the one wall of the product receiver cup. Reflux then drains into this cup through the U-tube vapor seal and into the product receiver. When the iron core is demagnetized, the iron wire is swung back into a vertical position by gravity. A vapor line from the top of the total condenser (not shown in Fig. 194) is connected to the product outlet line. The stopcock shown in the product line is not used during operation. It is helpful when the distillation is first started.

The stillhead developed by A. S. Carter and F. W. Johnson[36] is shown in Fig. 195. This liquid-dividing head is manufactured and sold by Ace Glass, Inc. This stillhead contains a swinging funnel to which is attached a glass-covered iron core. The funnel is drawn over a product receiver cup when an iron core is magnetized with an electromagnet coil and swings back into normal position when the iron core is demagnetized. When the funnel is in its normal position, reflux drains from a funnel just below the total condenser into the swinging funnel and into the third fixed funnel which is centered in the vapor tube from the column. The temperature is obtained by a partial immersion thermometer which is located in the ascending vapor line.

A stillhead with a swinging funnel has also been developed in the Shell Development Laboratories and described by F. C. Collins and V. Lantz.[7] The stillhead has a Dewar-jacketed total condenser which fits into the ground joint of the Dewar-jacketed liquid-dividing stillhead. This stillhead has a vapor tube leading to the condenser, a liquid return line to the column and a liquid product line which contains a vapor seal in the form of a U-tube.

Constant-ratio Stillheads

The constant-ratio head is a recent innovation in fractionating column stillheads. The design and application of such heads is discussed by L. Berg[37] and by L. E. Lloyd and H. G. Hornbacker.[38] These heads are called Corad heads—COnstant-RAtio heaD. These stillheads operate on the principle of two parallel condensing surfaces, one for product and the other surface for reflux. The Corad head developed by L. E. Lloyd and H. G. Hornbacker is shown in Fig. 196. This head is manufactured and sold by the Corning Glass Works. The head is fabricated for approximate reflux ratios of 1.5:1, 2.5:1, 5:1, 10:1, 20:1 and 30:1. The different ratios are obtained by turning the condenser which has drippers for each condensing area over the product receiving cup. The stillhead designed by L. Berg is shown in Fig. 197.

The advantages gained by using the Corad head are obvious. The reflux is dependent on condensing area exposed to the vapors. A change in boil-up rate in the column will effect the take-off rate in the same ratio as before. Conse-

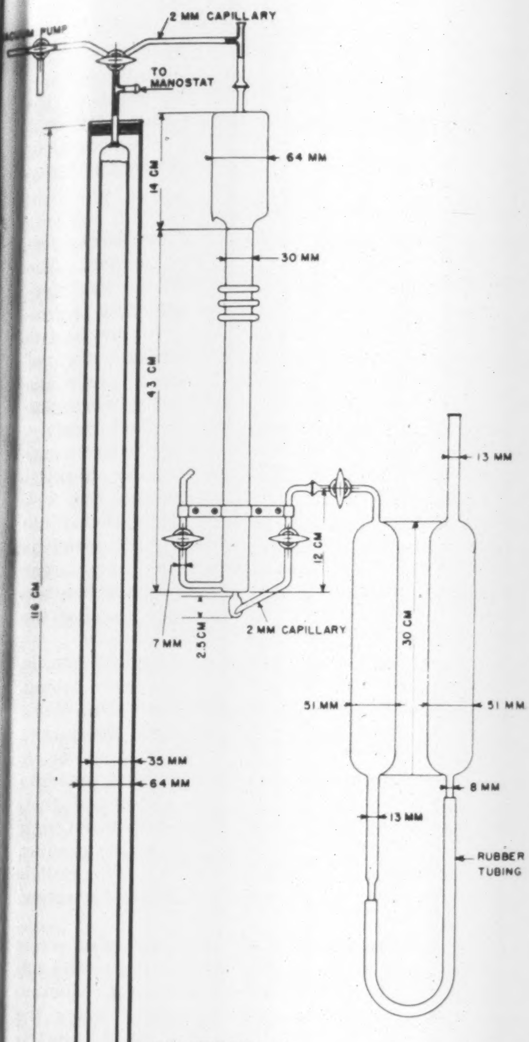
ACUUM PUMP
2 MM CAPILLARY
TO MANOSTAT
64 MM
14 CM
30 MM
43 CM
116 CM
12 CM
2 MM CAPILLARY
7 MM
2.5 CM
30 CM
13 MM
51 MM
51 MM
35 MM
64 MM
8 MM
13 MM
RUBBER TUBING
BALL FLOATS TO TOP AND CHECKS
TO MERCURY LEVELLING BULB ON MOTOR DRIVEN CARRIAGE

Fig. 198

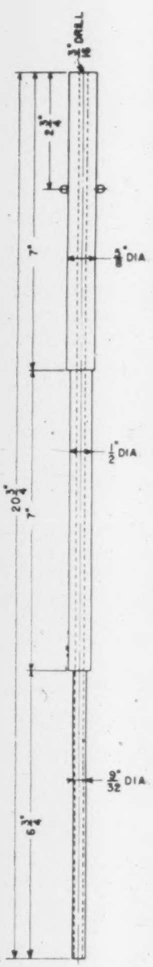
3/16" DRILL
2 1/4"
7"
3/8" DIA
1/2" DIA
20 3/4"
7 1/4"
9/32" DIA
6 3/4"

Fig. 199

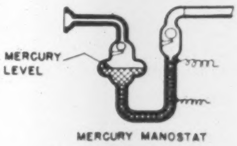
MERCURY LEVEL
MERCURY MANOSTAT

Fig. 200

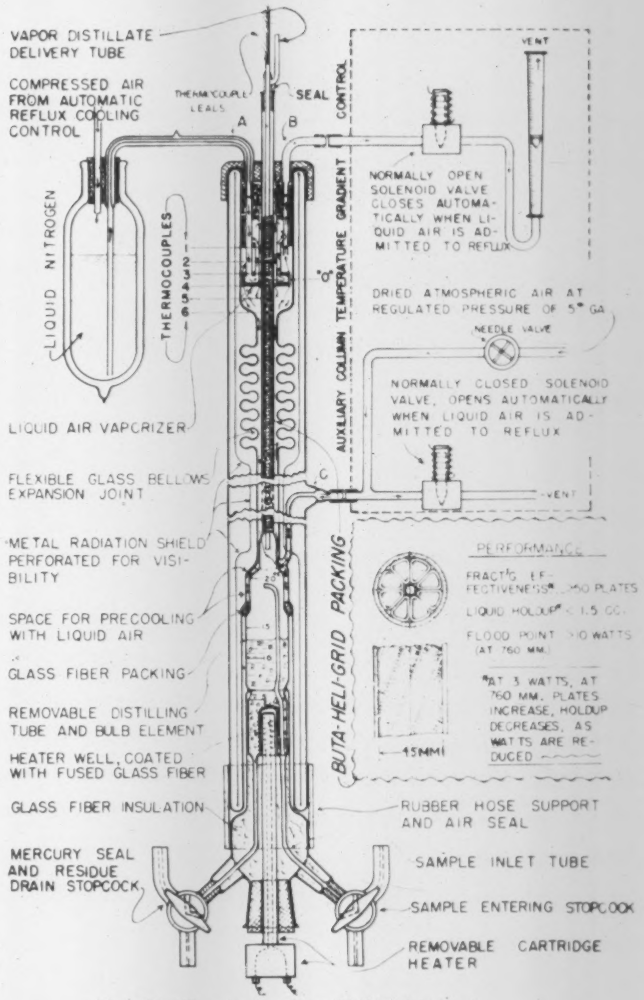
VAPOR DISTILLATE DELIVERY TUBE
COMPRESSED AIR FROM AUTOMATIC REFLUX COOLING CONTROL
THERMOCOUPLE LEALS
SEAL
A
B
AUXILIARY COLUMN TEMPERATURE GRADIENT CONTROL
VENT
NORMALLY OPEN SOLENOID VALVE CLOSES AUTOMATICALLY WHEN LIQUID AIR IS ADMITTED TO REFLUX
LIQUID NITROGEN
THERMOCOUPLES
1
2
3
4
5
6
DRIED ATMOSPHERIC AIR AT REGULATED PRESSURE OF 5" GA
NEEDLE VALVE
NORMALLY CLOSED SOLENOID VALVE, OPENS AUTOMATICALLY WHEN LIQUID AIR IS ADMITTED TO REFLUX
LIQUID AIR VAPORIZER
FLEXIBLE GLASS BELLOWS EXPANSION JOINT
C
VENT
METAL RADIATION SHIELD PERFORATED FOR VISIBILITY
BUTA-HELI-GRID PACKING
PERFORMANCE
FRACT'G EFFECTIVENESS* >50 PLATES
LIQUID HOLDUP* <1.5 CC.
FLOOD POINT >10 WATTS (AT 760 MM.)
*AT 3 WATTS, AT 760 MM. PLATES INCREASE, HOLDUP DECREASES, AS WATTS ARE REDUCED
15MM
SPACE FOR PRECOOLING WITH LIQUID AIR
GLASS FIBER PACKING
REMOVABLE DISTILLING TUBE AND BULB ELEMENT
HEATER WELL, COATED WITH FUSED GLASS FIBER
GLASS FIBER INSULATION
RUBBER HOSE SUPPORT AND AIR SEAL
MERCURY SEAL AND RESIDUE DRAIN STOPCOCK
SAMPLE INLET TUBE
SAMPLE ENTERING STOPCOCK
REMOVABLE CARTRIDGE HEATER

Fig. 201 (Drawing courtesy Podbielniak Inc.)

quently, changes in boil-up rates during a distillation are not too serious. Distillation of liquid which yield a condensate of two liquid phases also does not hinder the operation. One disadvantage which may be cited is that high reflux ratios (100:1) cannot be obtained without greatly increasing the area of the condensing surface.

FRACTIONATING COLUMNS FOR HYDROCARBON GASES

Fractionating columns for hydrocarbon gases have been developed as a laboratory tool for the analysis of gases. Such columns have been used with a great deal of success in the petroleum industry. The identification of gases obtained in various processes has been of greater value to this industry than purification of gases in small scale fractionating columns. Consequently, discussion of the construction of small fractionating columns will be devoted to equipment with which suitable analysis can be made.

A semi-automatic low temperature fractionating apparatus for the identification of hydrocarbon gases was developed in this laboratory. Several requirements were set up before the column and auxiliary equipment was designed and constructed. It was desirable to have a distillation apparatus which would give good results with gas sample volumes of 150 to 500 cc. These small samples made it necessary to have a column with a small hold-up as well as sufficient fractionation to identify various components in the gas mixtures. Semi-automatic operation was desired as the recording of distillation curves.

The assembly of the glass parts of this small fractionating apparatus is shown in Fig. 198. The various parts of the assembly will be described in the following discussion.

The Stillpot and Vapor Pump

The stillpot has a volume of about 3 cc. A glass vapor tube, 2 mm. bore capillary, is sealed into the side of the stillpot. The other end of this glass vapor tube is later sealed to a gas manifold containing two stopcocks and a mercury pump in respective order. Dimensions for the manifold and pump containers are given in Fig. 198.

The Column

The column is made from a 60-cm. length glass tube with an internal diameter of 2.5 to 3 mm. The bore of this tubing should be uniform. This tube is packed with a 45-cm. length of spiral made from No. 24 B&S copper wire. The spiral is wound to give two turns per centimeter length. A tapered jacket is machined from a copper rod. The form and dimensions of this jacket are shown in Fig. 199. A copper ring is soldered to the tapered jacket. A silvered glass jacket containing three outside expansion bellows and a side tube for periodic evacuations of the glass jacket is made as shown in the assembly in Fig. 198. The inside tube of this jacket has a diameter of 18 mm. The construction of the condenser flask has been previously discussed and illustrated in Fig. 143, A and B.

The column is assembled by inserting the small-diameter end of the copper jacket into the top of the condenser Dewar. This Dewar is moved into position under the copper ring near the top of the copper jacket. Several layers of adhesive tape can be used at this point to insure a seal between the Dewar and copper jacket. The silvered glass jacket is then slipped over the copper jacket and the annular space is filled

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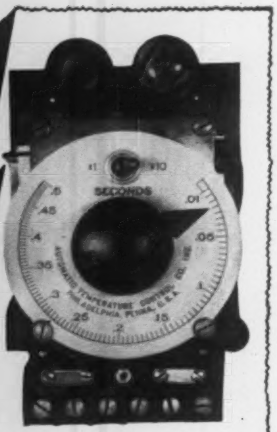
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with ground cork. The column is then slipped into the copper jacket. A spherical ground glass joint is sealed to the column about 2 cm. above the Dewar condenser.

A two-junction copper-constantan thermocouple is inserted through the top of the vapor line tee to a distance 2 cm. above the top of the spiral packing. The thermocouple wires are sealed into the one tube of the tee with DeKhotinsky cement.

The Vapor Manifold and Product Receiver

The vapor manifold must have as small a volume as possible. Two-millimeter bore capillary tubing is used. The manifold extends from the column through three-way stopcocks. The outlets of the first stopcock are sealed to the vapor line from the column, the product receiver line and to the one outlet of second stopcock. The remaining outlets of the second stopcock serve as lines to the vacuum pump and a drying and purifying train respectively. The pressure manometer is teed into the line going to the product receiver. This manometer must be cleaned periodically and consequently is best connected to the vapor manifold through a spherical glass joint. The pressure manometer is shown in Fig. 200. This manometer has two platinum contact points sealed into the glass. A small level change in the large leg which is connected to the vapor line causes a correspondingly larger change on the narrow contact leg. The manometer has two check balls which prevent the mercury from leaving the manometer.

The product receiver is about 100 cm. long and 35 mm. in diameter. It is jacketed with a section of 64 mm. tubing. This jacket serves as a constant-temperature bath. Water from a thermostated bath is pumped through the jacket. Mercury is the confining liquid in the product receiver. A glass ball on the mercury serves as a check which prevents the accidental transfer of mercury into the vapor manifold. The top outlet of the product receiver is ground to insure a good seal with the floating ball. The mercury in the product receiver is raised and lowered by a leveling bulb. This bulb is supported in a holder which is attached to an elevator screw.

Elevator Mechanism

The elevator or leveling device is a long threaded screw and collar. The mercury leveling bulb is attached to the collar. The screw is driven by an a-c. motor through a reduction gear. The motor is braked to prevent coasting after the current is turned off. The motor is connected to the electrical power source through the relay of a United Cinephone electronic switch, Model 8282. When contact is made in the pressure manometer the motor is started.

The mercury is lowered in the product receiver by the turning of the elevator screw until normal pressure is established in the vapor manifold. The elevator screw is connected directly to the advancing mechanism of the Leeds & Northrup recording potentiometer through a speedometer cable.

The Operation of the Semi-automatic Fractionating Column

Since the total volume of gas entering the product receiver is a measurement of chart length, it is helpful that two points be marked on the screw carriage. The first or zero point is the mark which gives a mercury level to the top of the product receiver. The second mark is arbitrary. This mark toward the bottom of the screw corresponds to chart travel and should be low enough to utilize the greater portion of the product receiver volume.

The apparatus should first be tested for leaks. The vapor line up to the stopcock nearest the still pot is filled with mercury and the stopcock is closed. The screw collar is set at the second point discussed above and the entire apparatus is evacuated to a pressure of about 1 mm. of mercury. The mercury rises in the product receiver equivalent to the barometric pressure minus the small residual pressure in the apparatus. This level is watched for several minutes after the apparatus is isolated from the pump. A drop of the mercury level in the product receiver indicates a leak.

The sample is introduced through a drying and CO_2 absorbing train into the product receiver. Sample from this receiver is allowed to flow into the vapor line and column by periodically turning the three-way stopcock until the gas in the apparatus is at atmospheric pressure.

The sample is transferred into the first receiver of the mercury pump. The carriage containing the leveling bulb is raised to the zero point mark after the connecting rubber tube is closed with a screw clamp. The stopcock nearest the stillpot is opened as the leveling bulb of the mercury pump is slowly lowered. The flow of gas from the product receiver to the pump reservoir is regulated by the screw clamp and the rate of lowering of the mercury pump leveling bulb. The pressure within the apparatus should not vary appreciably from atmospheric pressure in this operation.

The stillpot is cooled with a Dewar containing liquid nitrogen. Condensable gases in the column and vapor lines are condensed in the stillpot. When condensation is complete the condenser of the column is cooled by pouring liquid nitrogen into the condenser flask. The advancing mechanism of the recorder is connected to the speedometer cable and the power switch to the electronic relay thrown to the on position. The gas sample in the mercury pump reservoir is then slowly transferred to the stillpot. If non-condensable gases are present, as air or hydrogen, the contacts of the pressure manometer are contacted and the motor is started. The product receiver leveling bulb is lowered until the pressure in the apparatus is again restored to atmospheric pressure. The temperature is recorded on a chart during the lowering of the leveling bulb. When all the gas has been transferred to the stillpot and column, the condenser is maintained at liquid nitrogen temperature and the distillation is started by removing the liquid nitrogen Dewar from the stillpot. Usually sufficient boiling can be obtained by allowing the stillpot to warm slowly. A chilled empty Dewar around the stillpot will prevent air drafts and also allow sufficient boiling. The condenser is kept cold and a temperature gradient is set up between this point and the stillpot because of the tapered copper column jacket. As the distillation progresses, the chart shows definite plateaus for each component which can be separated by the column packing used. The distillation continues until the collar indicator reaches the end point mark.

Two corrections must be applied before the chart is complete. In all distillations, the gas must fill the lines beyond the thermocouple before the pressure manometer is activated. This correction can be made if the volume of this section is known as well as the total volume of the sample. This correction usually amounts to not more than 3 mm. of chart length and is added to the length of the first temperature plateau. The last temperature plateau of the distillation is short by the volume remaining below the thermocouple. This volume can easily be determined. The plateau length corresponding to this correction usually is about 8 mm. and is added to the final plateau if there is no material in the stillpot which cannot be vaporized at room temperature and atmospheric pressure.

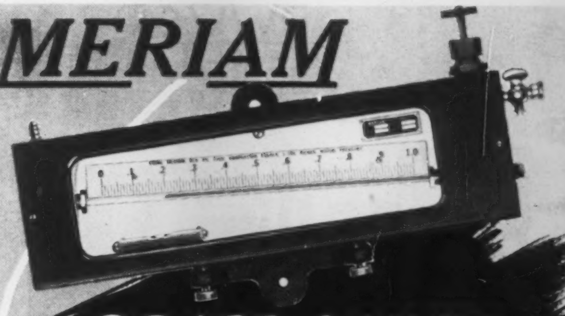
Binary mixtures of iso- and n-butane (which boil within 10°C.) exhibit a slight discrepancy in values observed, to the values actually present. It is possible to check synthetic blends and to draw up calibration curves which can be used for correcting the observed values.

The analysis of gas samples containing olefins requires two distillations. A sample for complete analysis of olefins and paraffins is distilled in the apparatus by the procedure outlined above. The total sample is brominated noting the contraction in volume. The gas remaining after the bromination is distilled. Results of the second distillation when multiplied by the contraction factor represent the paraffin content of each fraction in the original sample.

The Podbielniak Low-temperature Fractionation Equipment

A discussion of the low-temperature fractionation of hydrocarbon gases is not complete unless the extensive work of Podbielniak[5, 22] is mentioned. The low-temperature fractionation equipment which is available from Podbielniak, Inc., Chicago, Illinois is used in many laboratories. The "Heli-Grid" packing and a modification of this packing, the "Buta-Heli-Grid" packing, have been successfully used to obtain satisfactory separations for the analysis of gases.

The basic fractionating element of the Podbielniak apparatus, the "Super-Cool" column, is shown in Fig. 201. This apparatus with the multiple thermocouples along with a special "Buta-Heli-Grid" packing shown in the drawing is used



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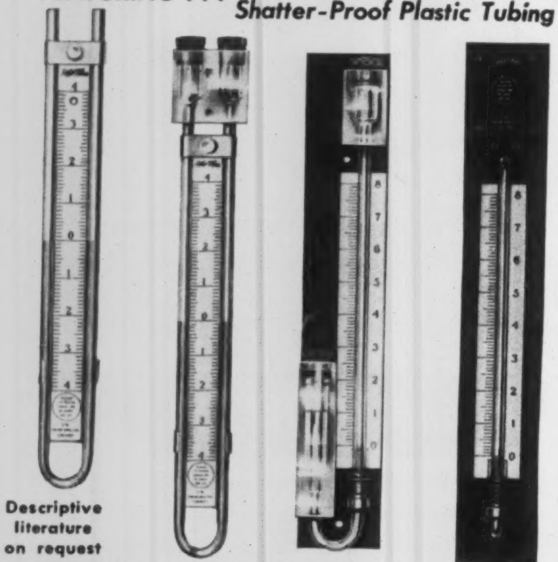

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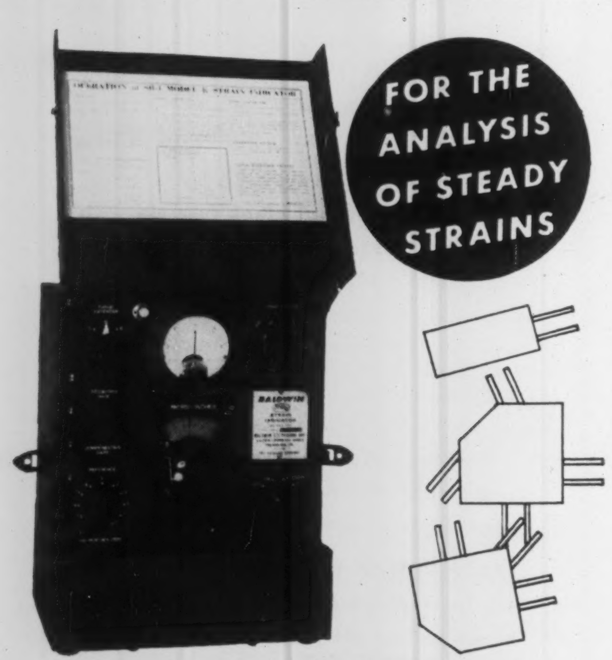

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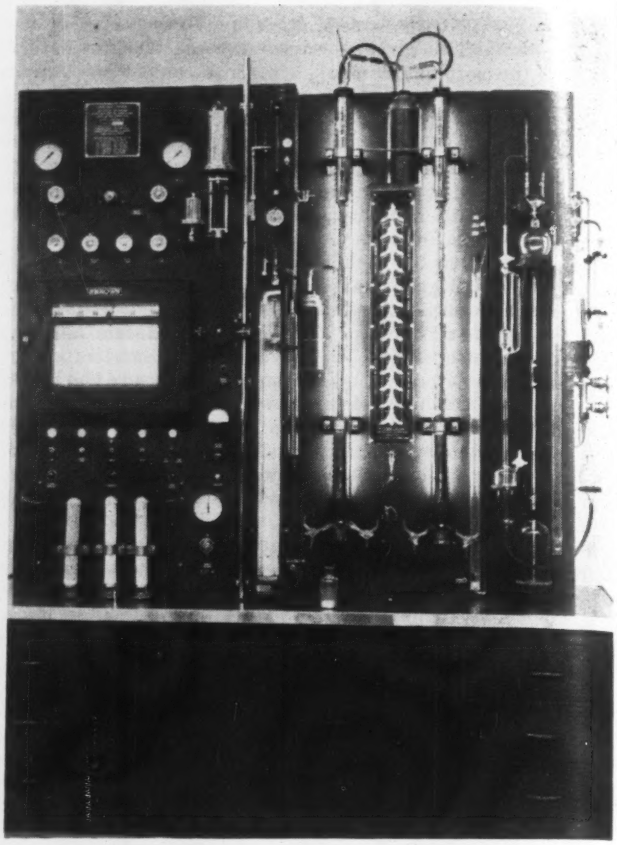


Fig. 202

in the "Heli-Tronic" fractionating apparatus for the analysis of C_4 and C_5 hydrocarbons. The columns shown in the "Hyd-Robot" apparatus, Fig. 202, are basically the same except that Heli-Grid packing is used along with a single junction thermocouple.

The "Super-Cool" column consists of a vacuum sleeve-type jacket with a sheet metal radiation shield. Enlargements at the top and bottom of the sleeve accommodate the stillpot and the special liquid nitrogen vaporizer and reflux cooler assembly. Liquid nitrogen vapors from the vaporizer pass downward through the annular space between the column and jacket to a point just above the stillpot and out through a glass vent tube to the outlet tube C. The sensible heat of the cold vapors from the reflux cooler is conserved by this arrangement as well as the neutralization of heat leakage through the vacuum jacket. The entire column can also be pre-cooled to liquid nitrogen temperatures in a short time by the cold vapors from the reflux cooler and the direct introduction of this refrigerant through the outlet at C before the gas sample is charged to the stillpot.

Dried air can be automatically introduced through the needle valve in a line leading to the side opening C. This dried air passes up through the annular space around the column giving a period of super-heating. This warms the entire column very rapidly at breaks, i.e., raising temperature to distilling temperature of next higher boiling component. The column can thus be super-cooled by the flow of cold vapors from the reflux head and super-heated with the flow of dried air.

The stillpot is designed so that samples can easily be introduced. Liquid residues can be withdrawn. Heat is supplied to the stillpot by a removable cartridge heater which extends into a heater well. The inner surface of the well is coated with fused glass fiber to facilitate boiling.

The "Hyd-robot" fully automatic distillation apparatus, Fig. 202, contains the following:

1. Two columns with stopcock manifold panel.
2. Automatic recording panel.
3. Multiple distillate receiver tank with five or six equi-volume one gallon bottles which are connected to the stopcock panel. The

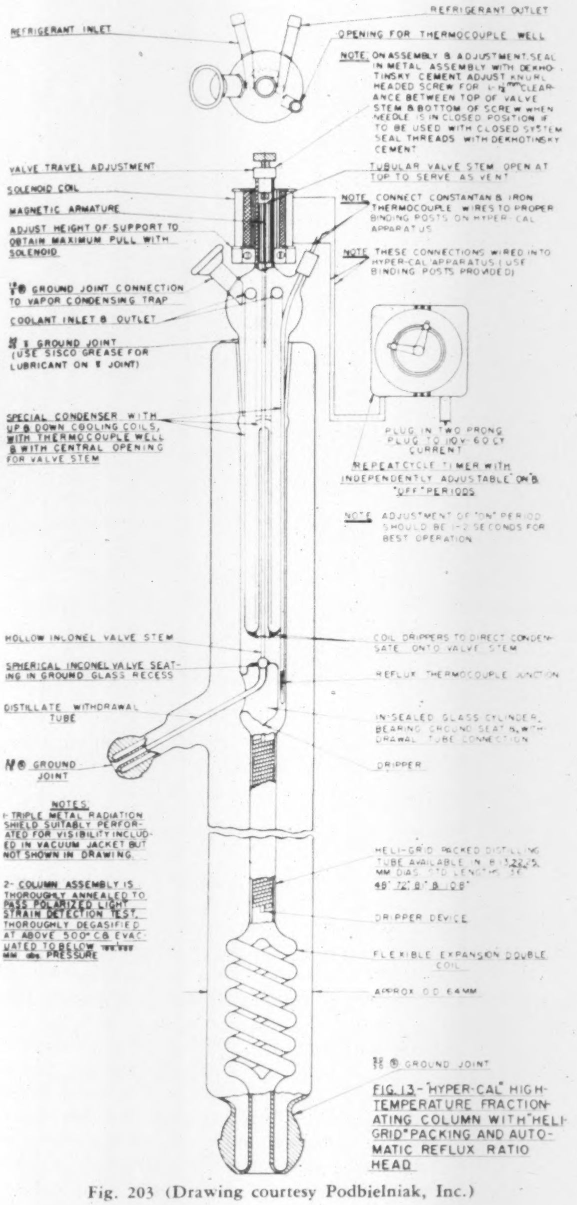
receiver tank can be supplied with an automatic constant temperature control.

4. Mercury pump panel.
5. Fraction collecting burette panel.
6. Auxiliary equipment as a vacuum pump, liquid air container apparatus for column operation.

Numerous other fractionating assemblies can be supplied to meet the demands of the laboratory.

Recent Developments in Hydrocarbon Analysis

Two important factors must be considered in the method of gas analysis, i.e., the manpower required and time consumed in the analysis. The recent trend in equipment design has been toward semi- or automatic fractionation equipment. The "Hyd-Robot" of Podbielniak, Inc., is a good example of the development of automatic distilling equipment. The time element is one factor which has received attention but unfortunately cannot be solved as easily as the design of automatic equipment. The fractionation process is inherently a slow process and, if extremely rapid fractionations are performed, small samples and extremely efficient packing must be used. Even under such conditions, analytical procedures also must be performed before the analysis is complete, i.e., when olefins are present in the gas samples. The development of infrared spectrophotometry and the mass spectrometer have aided greatly in decreasing the time required for


REFRIGERANT OUTLET
REFRIGERANT INLET
OPENING FOR THERMOCOUPLE WELL
NOTE: ON ASSEMBLY & ADJUSTMENT, SEAL IN METAL ASSEMBLY WITH DEKHOTINSKY CEMENT. ADJUST KNURL HEADED SCREW FOR 1-1½ mm CLEARANCE BETWEEN TOP OF VALVE STEM & BOTTOM OF SCREW WHEN NEEDLE IS IN CLOSED POSITION. IF TO BE USED WITH CLOSED SYSTEM SEAL THREADS WITH DEKHOTINSKY CEMENT
VALVE TRAVEL ADJUSTMENT
TUBULAR VALVE STEM OPEN AT TOP TO SERVE AS VENT
SOLENOID COIL
MAGNETIC ARMATURE
NOTE: CONNECT CONSTANTAN & IRON THERMOCOUPLE WIRES TO PROPER BINDING POSTS ON HYPER-CAL APPARATUS
ADJUST HEIGHT OF SUPPORT TO OBTAIN MAXIMUM PULL WITH SOLENOID
NOTE: THESE CONNECTIONS WIRED INTO HYPER-CAL APPARATUS (USE BINDING POSTS PROVIDED)
12/5 Ⓢ GROUND JOINT CONNECTION TO VAPOR CONDENSING TRAP
COOLANT INLET & OUTLET
34/45 Ⓢ GROUND JOINT (USE SISCO GREASE FOR LUBRICANT ON Ⓢ JOINT)
SPECIAL CONDENSER WITH UP & DOWN COOLING COILS, WITH THERMOCOUPLE WELL & WITH CENTRAL OPENING FOR VALVE STEM
PLUG IN TWO PRONG PLUG TO 110V-60 CY CURRENT
REPEAT CYCLE TIMER WITH INDEPENDENTLY ADJUSTABLE "ON" & "OFF" PERIODS
NOTE: ADJUSTMENT OF "ON" PERIOD SHOULD BE 1-2 SECONDS FOR BEST OPERATION
HOLLOW INCONEL VALVE STEM
COIL DRIPPERS TO DIRECT CONDENSATE ONTO VALVE STEM
SPHERICAL INCONEL VALVE SEATING IN GROUND GLASS RECESS
REFLUX THERMOCOUPLE JUNCTION
DISTILLATE WITHDRAWAL TUBE
IN-SEALED GLASS CYLINDER, BEARING GROUND SEAT & WITHDRAWAL TUBE CONNECTION
N Ⓢ GROUND JOINT
DRIPPER
NOTES:
1- TRIPLE METAL RADIATION SHIELD SUITABLY PERFORATED FOR VISIBILITY INCLUDED IN VACUUM JACKET BUT NOT SHOWN IN DRAWING.
2- COLUMN ASSEMBLY IS THOROUGHLY ANNEALED TO PASS POLARIZED LIGHT STRAIN DETECTION TEST, THOROUGHLY DEGASIFIED AT ABOVE 500° C & EVACUATED TO BELOW 1/100,000 MM abs PRESSURE
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APPROX O.D. 64MM
29/26 Ⓢ GROUND JOINT
FIG. 13 - "HYPER-CAL" HIGH-TEMPERATURE FRACTIONATING COLUMN WITH "HELI-GRID" PACKING AND AUTOMATIC REFLUX RATIO HEAD

Fig. 203 (Drawing courtesy Podbielniak, Inc.)

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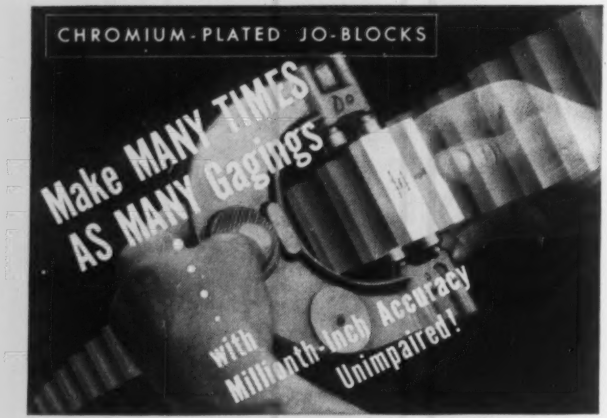
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gas analysis. New and advanced techniques have been developed which have made possible very rapid control analysis. It is beyond the scope of this work to discuss the techniques and equipment used in infrared spectrophotometry and the mass spectrometer. It will suffice to mention that fractionation of gas sample into fractions and analysis of the more complex fractions by infrared spectrophotometry is being used in many laboratories.

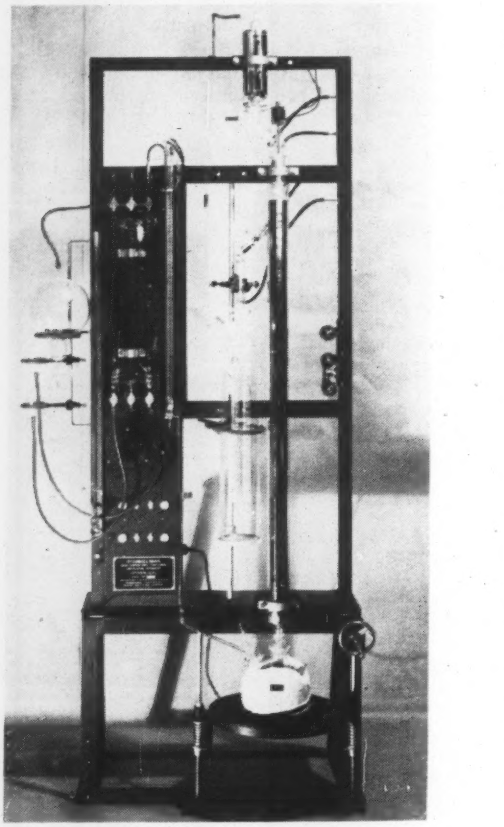
Fig. 204

DISTILLATION COLUMNS FOR THE FRACTIONATION OF NORMALLY LIQUID HYDROCARBONS

The development of laboratory columns for the fractionation of liquid mixtures boiling in the range of 25 to 250 C has been very extensive. Design problems for this class of fractionating columns are quite simple. Columns can be designed to accommodate specific types of packing which can be used to meet the requirements of many different distillation problems.

The distillation problem should be reviewed before the fractionating column is designed and constructed. The facilities available (manpower and electrical power sources), the amounts of charge to be fractionated and the degree of fractionation required are factors which have a direct bearing on the design and packing used in the column. The column should be so designed to permit a vapor velocity of 1 meter a second. In view of the previous discussion of the individual parts of a fractionating column, it will not be necessary to discuss the column assembly except to give examples of several columns which have been used.

The Podbielniak "Hyper-Cal" Column

The Podbielniak Hyper-Cal column[22] is shown in Fig. 20 The condenser is a double loop of glass tubing with drippers at the bottom tip of the loop. These drippers direct the reflux into the valve stem. A glass cylinder between the condenser and packing decreases the vapor space. This cylinder contains the valve seat and a reflux dripper. The reflux thermocouple junction is located beside this cylinder. Product removal is controlled by a solenoid valve which is operated by a repeat cycle timer with adjustable "on" and "off periods. Product receivers are connected to the column through a 28/15 spherical ground glass joint. The expansion of the column is compensated with a double expansion coil at the bottom of the column. The assembly of the Hyper-Cal column which is available from Podbielniak, Inc. is shown in Fig. 204. An automatic distillation unit containing a Podbielniak Super-Cal, Model B, distillation unit is described by L. Steffens and D. P. Heath.[39]

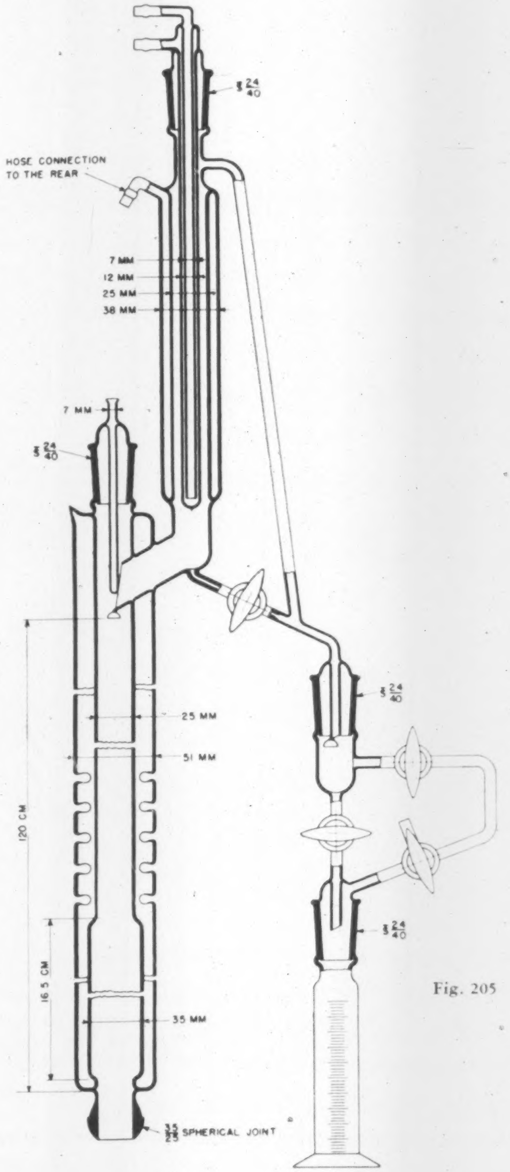

Fig. 205

Laboratory Fractionating Column for Manual Control

The vacuum jacketed column shown in Fig. 205 is designed for manual control of the reflux. This column can be fitted with any of the other stillheads that have been previously discussed. The vacuum jacket is silvered to the reflux drop counter or strip silvered. The inside bellows allow expansion of the tube containing the packing. The short section of the column at the bottom which has a larger diameter is used as a knock-down section for high boiling components. Dump-in packing is supported by using a wire gauze cone which can be forced into the spherical joint opening. Tension of the deformed cone is released when the cone is pushed into the larger bore tubing. The apex of the cone should point toward the top of the column while the base of the cone rests on the shoulder formed by the seal between the large and small tube.

Another column which is designed for manual control of reflux is shown in Fig. 206. No jacket is shown around the

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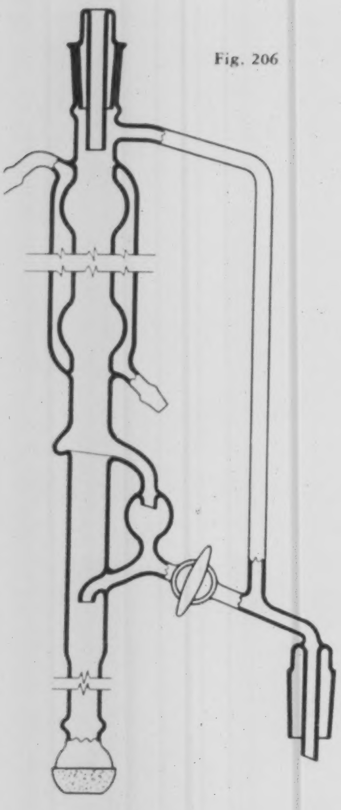

Fig. 206

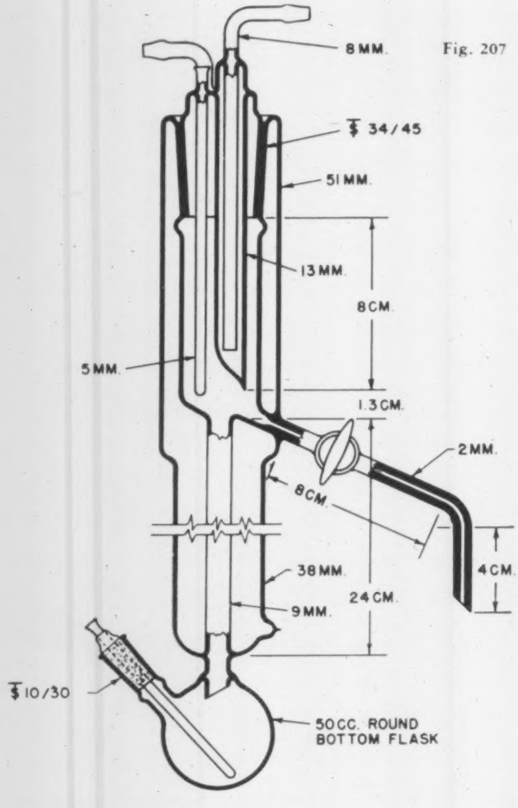

Fig. 207

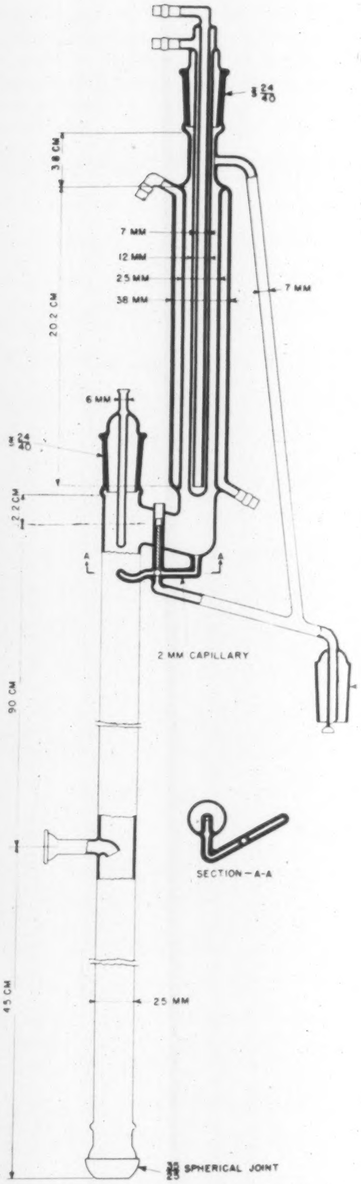

Fig. 208

column. The choice of insulation may be as shown in Fig. 190A or 190C. This column as shown is designed for the dump-in types of packings. The small enlargement near the bottom of the column is for the packing support.

Small-residue Fractionating Column

If a survey is made of the various column packings, it will be noted that each has a certain operating hold-up which make it impossible to make a complete fractionation analysis of the mixtures charged to the column. Smaller columns could be used by sacrificing throughput. The second expedient is to use a smaller column for the fractionation of the residue. A column designed for the fractionation of residues is shown in Fig. 207. The packing should naturally be of the type with a small hold-up. A glass spiral, 6 turns per inch of 3-mm. rod, which fits into the column after it is wound on a glass rod, has been successfully used.

The reflux ratio is controlled by the stopcock. The column is started by turning the condenser so that reflux flows directly to the packing. Product can be removed by turning the condenser so that reflux is directed into the product removal line. The vapor temperature is obtained by a thermocouple in the well which is ring sealed into the inner member of the ground glass joint.

Continuous Laboratory Fractionating Columns

Small continuous distillation units which contain a stripping and fractionating section are very useful for separating mixtures. These columns can be adapted to the fractionation of products from small scale bench scale units especially if the fore or the last portion of a mixture must be separated from the remainder of the product. If a portion from the middle of the product is desired, two distillations must be made or two columns must be used. The small continuous columns have certain advantageous over batch distillation columns. The columns can be operated as product is being produced, large amounts of a mixture can be fractionated without the use of large and cumbersome stillpots and the results obtained by using continuous columns are comparable to those of batch fractionations.

Very few small continuous distillation columns are reported in the literature. R. W. Hufferd and H. A. Krantz[40] have described a small continuous metal column along with some tests of fractionating a binary test mixture. The column which has been successfully used in this laboratory is as illustrated in Fig. 208. The charge is pumped into a preheater (not shown) which is connected to the inlet tube in the lower mid section of the column. This preheater consists of a vertical tube 40 cm. long and 18 mm. in diameter. A thermowell which extends the entire length is ring-sealed into the top of the tube. The tube is filled with glass chips. An inlet is sealed to the top of the tube. The preheated charge flows into the column through a tube and spherical joint which is sealed to the bottom of the preheater. Hufferd and Krantz described a preheater which consists of a steel tube coil cast in aluminum. The preheater is wound with tape and an electrical resistance heater and finally lagged with magnesia pipe covering. The column is insulated as shown in Fig. 190A. At least two electrical resistance heaters are necessary, one for the stripping and a second for the fractionating section.

The stillpot (not shown) must contain a thermowell, a sight gage for level indication and a line for the removal of bottoms. The stillpot can be made from a large tube, the size of which depends on the size of the column. A stillpot of 500-cc. capacity is large enough for the column shown in Fig. 208. The sight gage can be sealed at the top shoulder and the bottom outlet tube. An electrical resistance heater is wound on the stillpot.

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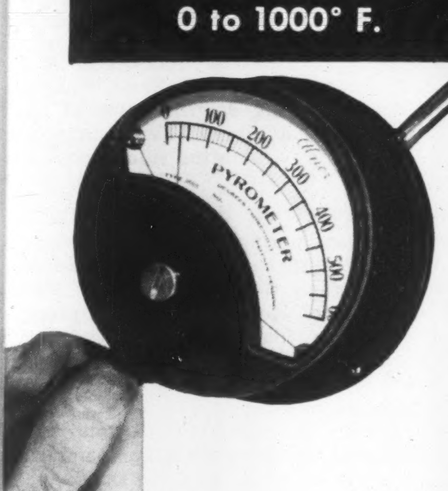

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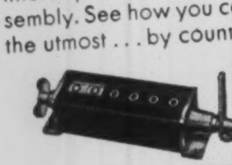

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which contains a small glass ball solenoid valve. Product is removed during "on" periods of a cycle timer. The adjustable "Flex-o-pulse" cycle timer of the Eagle Signal Corporation is satisfactory.

The column can be operated at a constant overhead temperature because the product has a constant composition. If an electrical temperature controller is available, as a Leeds & Northrup "Speedomax" controller, a thermocouple can be used for recording temperatures. This controller can be set at a definite temperature and when this temperature is exceeded, the relay in the controller will shut off the current to the solenoid coil. The column will thus operate at total reflux until the temperature is lowered to the desired overhead temperature. The relay in the controller then closes the circuit to the solenoid coil which opens the valve when the cycle timer moves through the "on" position.

If a temperature controller is not available, a simple mercury thermoregulator can be built into the cap of the ground glass joint which contains the thermowell in Fig. 208. An adjustable contact screw will permit adjustment to the desired overhead temperature. The mercury bulb of the regulator should be located in the vapor stream.

The operation of a small continuous column is not difficult provided a constant pumping rate of the charge is maintained to the preheater. The column will attain the equilibrium conditions possible under the operating conditions. If rapidly changing rates are used this equilibrium is disturbed and poor stripping or fractionation can be expected.

Evaluation of Fractionating Columns

The evaluation of fractionating columns has been described in the literature and will not be given here. C. C. Ward[41] has summarized the methods proposed by M. R. Fenske[42] and by B. F. Dodge and J. R. Huffman[43] and has given sample calculations for the determination of theoretical plates in a fractionation column. Four binary test mixtures which can be used for evaluating columns are also given.

VACUUM FRACTIONATION EQUIPMENT

The design of proper fractionating equipment for vacuum distillation has received little attention by many laboratory technicians. Columns designed for distillations at atmospheric pressure are frequently used under reduced pressure for no other reasons except that good separations were obtained at atmospheric pressure. One has but to make a preliminary calculation of the vapor velocity in the columns under reduced pressure to realize the folly of such an attempt. The conditions which prevail under vacuum require special considerations for column design. It was pointed out that a suitable value of the linear velocity for the design of columns at atmospheric pressure is 1 meter per second. A reduction in pressure from 740 to 7.40 will yield an approximate hundredfold increase in velocity. The linear velocity for vacuum column design should thus be 100 meters a second. One need not then be astonished that atmospheric columns are but poor substitutes as columns for low-vacuum distillations. The vapor velocity is too high in the packed column operating at reduced pressure and no equilibrium between reflux and vapor can be expected. In fact, the liquid reflux can be swept through portions of the packing causing vapor channeling in the other portions. Under the conditions of high vapor velocities in a packed column containing reflux, the pressure drop through the column is high enough that excessive temperatures cannot be avoided in the stillpot.

Considerable interest has recently been displayed in the development of low vacuum fractionating equipment. The design and construction of fractionating columns which can be successfully used in the vacuum range of 5.0 to 0.01 mm. of mercury is not easy because only a very low pressure drop can be tolerated. Another drawback which has hindered the widespread development of low vacuum fractionating columns has been the absence of vapor-liquid equilibria data of binary systems which could be used for testing such columns. F. E. Williams[44] recently studied the system di-n-butyl phthalate and di-n-butyl azelate at 1 mm. of mercury. Vapor-liquid equilibrium data were obtained at this pressure in a simple equilibrium still. Two vacuum fractionating columns were tested at total reflux with this binary mixture. The first column consisted of a vacuum-jacketed empty tube 180 cm. long and 13 mm. in diameter. The second column consisted of 40-mm. Trubore glass tube, 120 cm. long, fitted with an aluminum spiral made by machining square threads on an aluminum rod. The root diameter of the square thread was 12 mm. and the pitch was two turns per inch. Data of the tests when the pressure at the condenser was 1 mm. of mercury show that the empty tube had from 2.9 to 4.5 theoretical plates at total pressure drops of 1.04 and 3.2 mm. of mercury, respectively. The tests on the spiral column showed 12.6 and 10.8 theoretical plates at respective pressure drops of 0.88 and 4.0 mm. of mercury.

E. S. Perry and R. E. Fuguitt[45] have studied the vapor-liquid equilibria of two binary systems, di-2-ethylhexyl phthalate-di-2-ethylhexyl sebacate and di-n-octyl phthalate-di-2-ethylhexyl sebacate at 0.1 mm. of mercury. The first binary system has a relative volatility of 2.85 and is recommended for vacuum columns with low efficiencies. The second binary mixture has a relative volatility of 1.21 and consequently can be used for testing efficient vacuum columns.

S. F. Birch, V. Gripp and W. S. Nathan[46] have described a high-vacuum fractionating column. The column contains an 18 gage stainless steel rotor which is twisted 360°. The column was used in the range of 0.01 to 2.5 mm. of mercury and at stillhead temperatures of 80 to 200°C. A pressure drop of 0.03 mm. of mercury was obtained when the boil-up rate was 300 cc. per hour. The fractionating power of the column was shown to be greatest at a rotor speed of about 300 r.p.m.

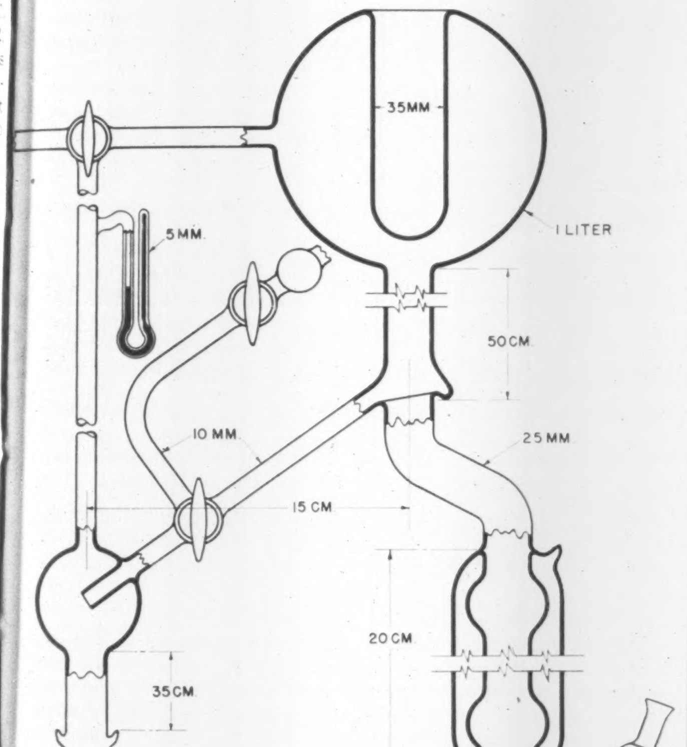

Fig. 209

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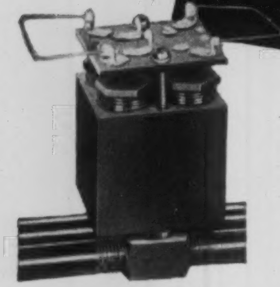

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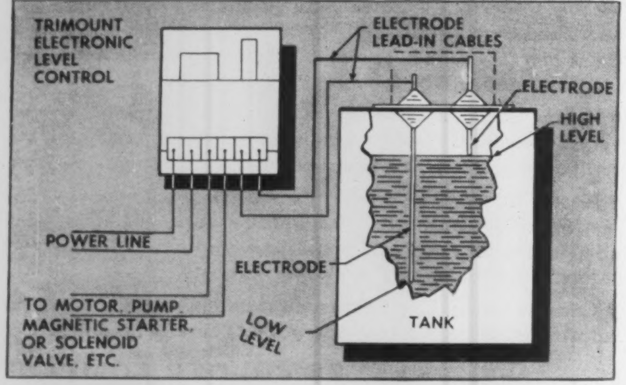
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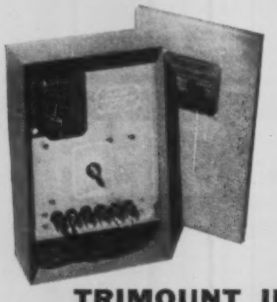

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R. Schaffner, J. R. Bowman and J. Coull[47] have approached the problem of high vacuum fractionation by employing a multiple redistillation principle. The column is a vertical 38 mm. tube, 5 feet long, which contains 12 heated and 12 air cooled zones. The heated zones are 5 cm. long and are wrapped with electrical resistance heaters. Each heated section contains a ⅛" Kovar rod spiral with a pitch of ¼". This spiral which is located inside the column retards the flow of condensate and offers a larger heated surface area. The cooled sections, one of which is located at the top of the column, are cooled with air jets. The partial condenser and stillpot are of a conventional design.

The column operates on the principle of vapor rising in the tube and the countercurrent flow of reflux. Vapors are condensed on the cooled sections and flow to the heated section where they are revaporized. Light components are stripped out of the reflux and the heavy components are returned as reflux. The column has been operated with a test mixture of meta- and para-tricresyl phosphate. The equivalent number of plates of the column were about fifteen.

A useful potstill for low vacuum distillations is shown in Fig. 209. The vapor tube offset acts as a mist trap and successfully prevents liquid carry-over into the product. The vacuum jacketed empty tube offers but little fractionation. The manifold of this still is so arranged that distillate fractions can be removed without breaking the vacuum in still.

MOLECULAR OR SHORT-PATH DISTILLATION

Molecular or short-path distillation has become an important commercial separation process,[48, 49] the development of which was possible by virtue of its unique characteristics for separating high boiling and heat unstable compounds. The demands of such materials as vitamin A has encouraged the extensive study of methods for performing molecular distillation on a commercial scale. Research on the development and application of laboratory stills has accompanied the commercial development. No attempt will be made to trace the interesting evolution of molecular distillation. The reader is referred to the work of K. C. D. Hickman,[49] S. B. Detwiler,[50] C. R. Burch,[51] E. W. Fawcutt,[52] G. Burrows[53] and H. I. Waterman.[54]

Molecular distillation may be basically described as a molecular transfer of constituents in a mixture from an evaporating surface to a parallel condensing surface. The residual gas pressure is low enough that the mean free path of the molecules exceeds the distance between the two surfaces. This process of molecular transfer takes place in four steps:[49]

1. The transfer of molecules to the liquid surface.
2. Molecular release at the surface of the liquid.
3. Molecular transfer through the residual gas in the vapor gap between the evaporator and condenser.
4. Condensation.

Equipment design is directly related to these four steps. Since construction of molecular stills will be considered in this section, a discussion of the various basic parts is warranted.

The Evaporator

The essential factor which must be considered in the design of the evaporator is the method of distributing the distillant on the evaporating surface. Quiet surface evaporation is obtained under the low pressure distillation of mixtures containing compounds with high molecular weights. A solution of the evaporation problem as well as preventing excessive decomposition is to spread the distillate over the evaporator in a thin film. Vertical glass and polished chromium-plated nickel has been recommended as suitable evaporator surfaces for falling film molecular stills.

The renewal of the surface of the distillant deserves some comment. F. W. Quackenbush and H. Steenbock[55] used the expedient of moving rotor composed of three vertical glass rods over the surface of a vertical evaporator. This rotor spreads the liquid over the evaporator and continually exposes constituents below the distillant surface. Glass evaporators with glass rod spirals have been used. A still with spirals will be described later. It should be pointed out that if the spiral fits tight around glass evaporator, some flow of distillant will be obtained along the spiral. Consequently, fairly thick liquid layers will be obtained which favors thermal decomposition.

The introduction of the centrifugal still[49] by Distillation Products, Inc. illustrates still another method of obtaining a thin film on the evaporator. This evaporator is circular heated rotor with a shallow cone surface. The distillant is fed to the center of the cone. Rotation of the rotor forces the liquid to the outer edges where it is caught by a rotating gutter at the rotor periphery. The residue is collected by a pickup from which it flows to the residue storage flask. The layer of distillant is much thinner on this evaporator than the falling film discussed above. Evaporated materials are collected on a condenser which is located directly in front of the rotor.

The method chosen for heating the evaporator depends on the type of still. Electrical resistance heaters can be used provided the heat can be equally distributed. Small laboratory stills are also heated by boiling certain compounds in a confined heating system.

The Condenser

The condenser does not require special designs except that it should be parallel and near the evaporator. It is no problem to condense the high molecular weight compounds which are distilled in a molecular still. Water or, more generally, air cooled condensers are adequate.

The Degasser

Any organic liquid which is exposed to the atmosphere dissolves a certain amount of air. When this liquid is subjected to vacuum in the order of 0.001 mm. of mercury and elevated temperature, the air is released and foaming results. Since the space between the evaporator and condenser is small, foaming is to be avoided because of the danger of contaminating the evaporated product. It is, therefore, necessary to have a degassing section in the molecular still. A glass tube wrapped with an electrical resistance heater is quite satisfactory for small laboratory stills. The charge to the molecular still is first pumped through this heater with successive reductions in pressure until the oil is entirely degassed. It can then be pumped to the evaporator.

Vacuum System

The vacuum system will require a good mechanical and a high speed condensation pump. All vacuum lines should be large so that the high speed condensation pump is not throttled. The measurement of pressure within the molecular still requires a gage which does not affect the pressure within the still. K. C. D. Hickman[49] has chosen the Pirani gage which is periodically calibrated with a McLeod gage. The latter gage is used on the dual molecular still in Fig. 210 and appears to be the choice of numerous small laboratory stills, even though this gage fails to register condensible vapors.

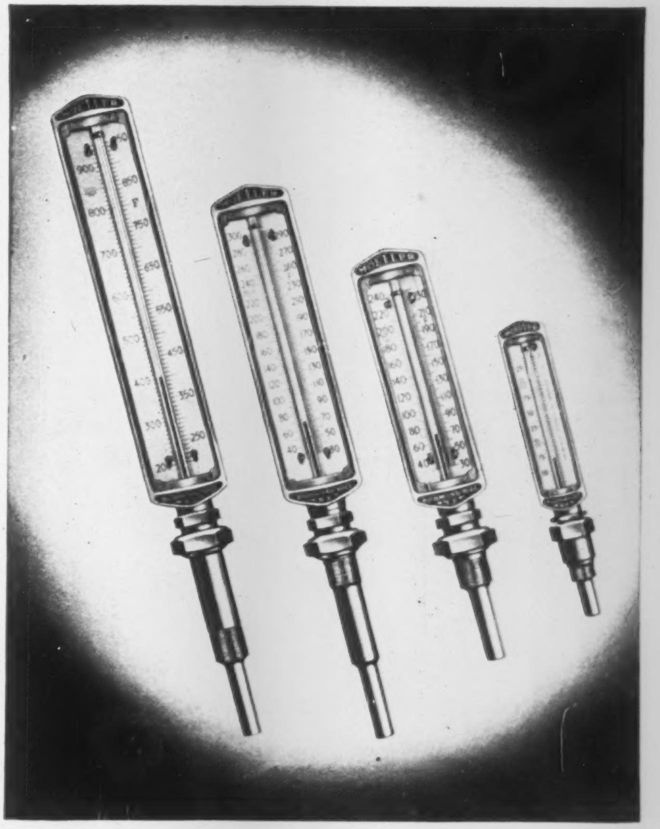
Construction of a Laboratory Molecular Still

A dual falling film molecular still is shown in Fig. 210. This still consists of the following parts:

1. Charge and residue receiver containing two reservoirs connected by a tube. A glass solenoid valve is used to isolate the top receiver from the bottom when residue is being collected during operation.
2. A small gear pump.
3. A tube degasser.
4. A falling film evaporator containing a xylene boiler heater and a water cooled condenser.
5. A falling film evaporator containing a mercury boiler heater and an air cooled condenser.
6. A high speed oil condensation pump. The pump used in this system is the glass-metal oil pump, Type 6M-220 sold by Distillation Products, Inc.

Only a few new construction details have not been described in the preceding chapters. The construction of the two evaporators deserves some comment. The 3 mm. glass rod is wound on the 25 mm. tube in the following manner:

A four-foot section of 25 mm. tubing is wrapped with single layer of 0.015″ asbestos tape. The 3-mm. rod is sealed directly to the 25-mm. tube about 6″ from one end. The rod is then wrapped over the asbestos paper by heating the rod and rotating the tube. About one turn per inch is satisfactory. After a sufficient length of spiral is obtained, the rod is again sealed to the evaporator tube. The asbestos paper



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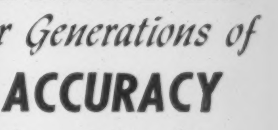

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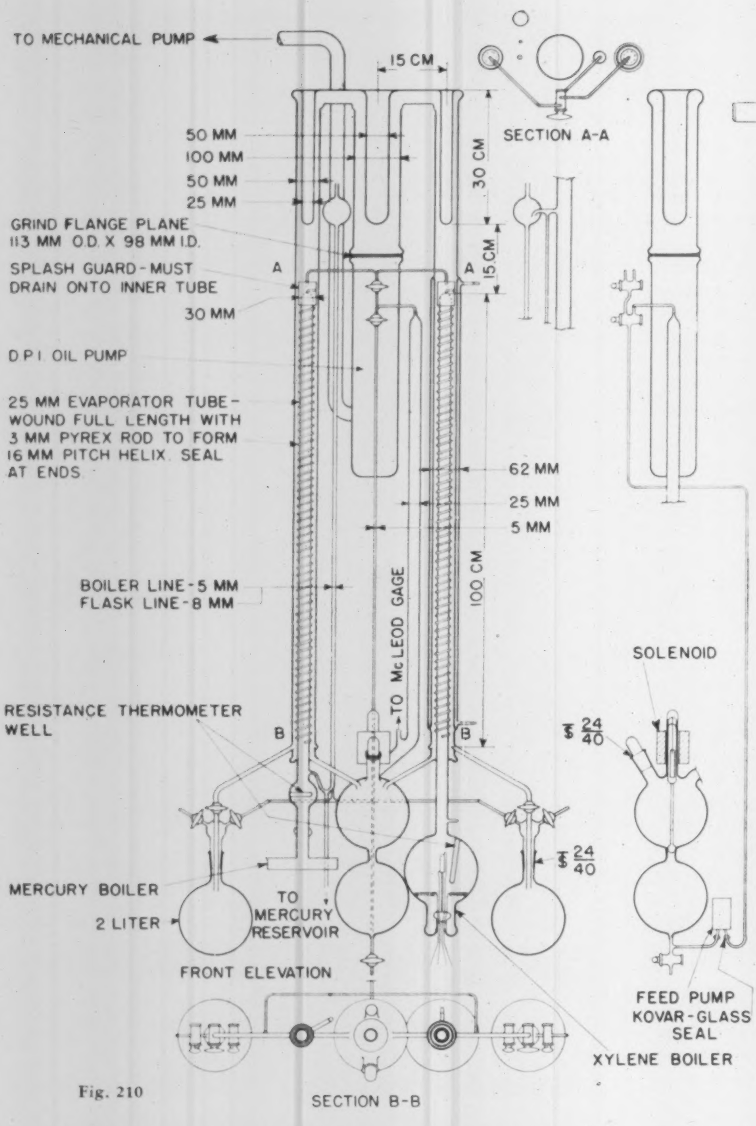
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Fig. 210

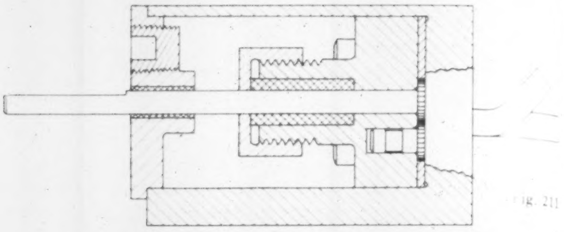

Fig. 211

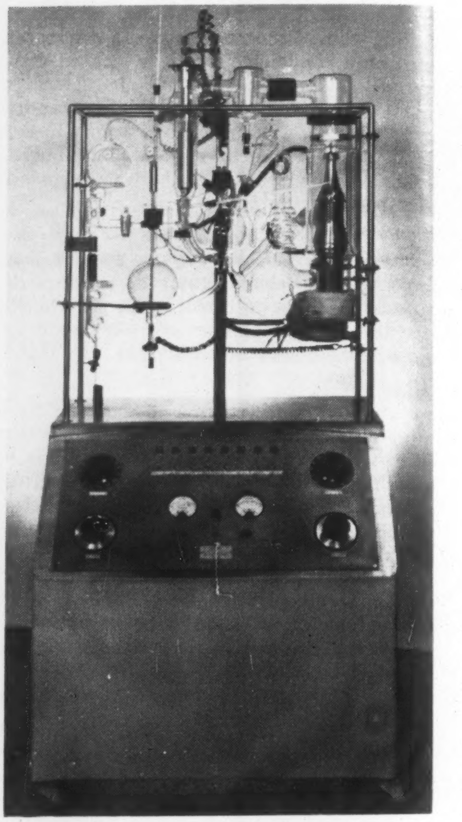

Fig. 212

is removed by soaking it in water and pulling it out from under the spiral.

The xylene boiler contains a coil immersion heater and a resistance thermometer. The four leads are sealed into the glass through a press seal which has been previously described. This boiler is filled with xylene to a level 1" above the immersion heater through the tubulation at the side of the evaporator tube. The xylene is then pumped for a short time to remove dissolved air. It is then frozen by immersing the entire flask in a dry ice bath and the tube and flask are evacuated. The system is then closed by sealing the tubulation.

The mercury boiler consists of a flat metal boiler which is sealed to the glass through a glass-to-Kovar seal. The boiler was previously illustrated in Fig. 83. A ring electrical heater is used to heat the metal boiler. Temperatures of both boilers can be obtained with thermocouples. The mercury boiler also has a temperature indicator which consists of a tube with a small U-tube mercury seal. This tube extends from the glass tube of the mercury boiler to the outlet tube of the condensation pump. The mercury boiler is evacuated through this tube. A line into the U-tube seal from a mercury reservoir below the still is used to seal off the boiler from the vacuum system after the boiler is evacuated. The temperature indicator bar is marked off in temperatures at the heights corresponding to the vapor pressure of mercury.

Both evaporators have splash guards which prevent splashing at the point where the charge enters the still. These guards are spaced to allow the liquid to drain over the evaporator.

Feed Pump

The feed pump shown in Fig. 211 consists of a small gear which can be connected to a variable speed motor and gear box arrangement. Leakage through the pump shaft is prevented by a long stuffing box backed by an oil filled chamber. Kovar tubes which can be soldered to the pump for the inlet and outlet lines after glass-to-Kovar seals are made.

Operation of Molecular Still

The operation of a molecular still will depend on the material which is being distilled and the object of the distillation. The degree of separation obtained in a single pass over the evaporator is generally less than one theoretical plate. The distillation does not exhibit definite temperatures as obtained in fractionating columns because the residual pressure is very low in the molecular still. Evaporation from the still evaporator takes place when a difference of temperature is maintained between the evaporator and condenser. The rate of feed to the evaporator, provided a temperature gradient between evaporator and condenser is maintained, will also result in different fractions.

Distillation techniques have been developed by K. C. D. Hickman[49, 56] and N. D. Embree[57] which are based on the curve obtained by plotting percent yield of a constituent in the various collected fractions against the temperatures of distillation. The circulating batch stills shown in Fig. 210 and 212 can be used for obtaining data for such curves. The mixture is charged to the still and circulated at a constant feed rate while product is removed at a constant evaporator temperature. The temperature is then raised and maintained

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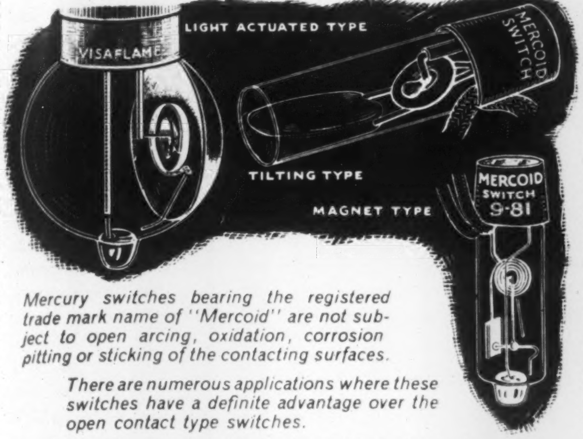

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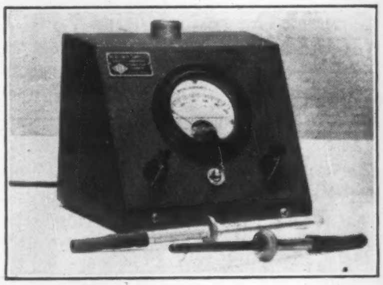

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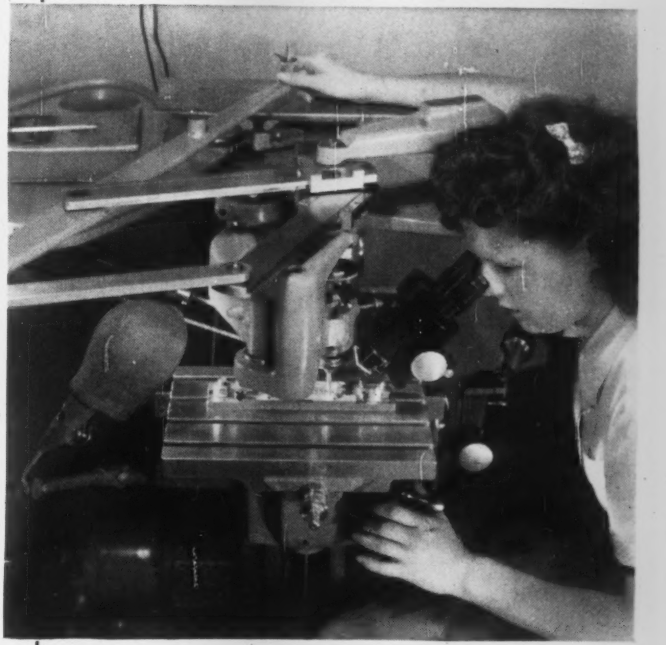

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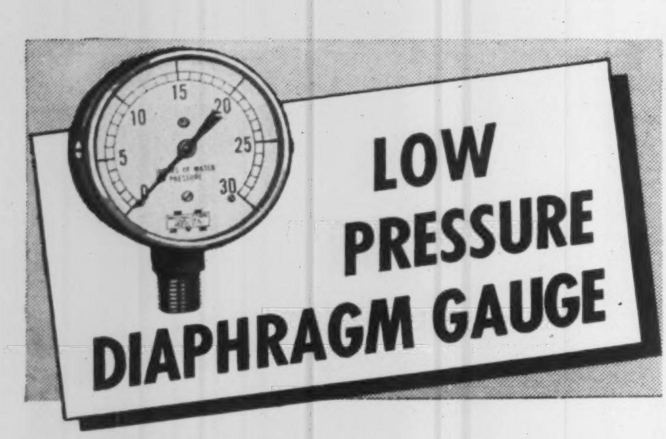

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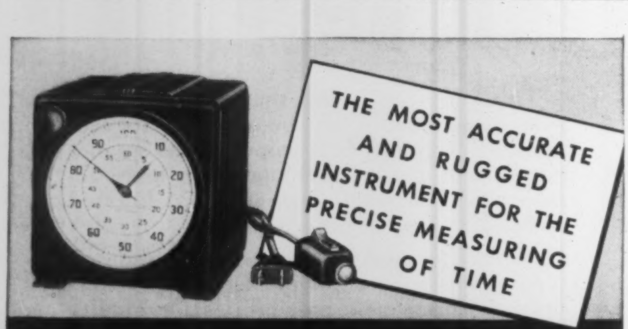
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at this temperature until the second fraction is collected. This process is repeated until all fractions are obtained. If some means is available for analyzing the amount of the constituent in each fraction, it will be noted that a maximum is obtained in the percent yield-temperature curve. Dyes mixed with oils have been used for determining the effectiveness of molecular still. The amount of dye in each fraction is determined colorimetrically.

Hickman[49] has gixen a thorough discussion of various applications of the elimination curve techniques. This publication should be carefully studied for information concerning further application of the molecular still.

The operation of a molecular still, Fig. 210, consists of degassing the mixture and then collecting fractions at various evaporator temperatures. The degassing step consists of using a constant temperature in the degasser. The oil is recycled through the degasser as the pressure is lowered in steps as 10, 1, 0.01, 0.001 mm. of mercury. This is accomplished by controlled leaks. When the mixture is degassed and the desired vacuum is reached, the mixture is pumped to the evaporator, which is held at a constant temperature. A feed rate of 1.2 liters per hour has been used on the still illustrated in Fig. 210. The fraction is collected at this temperature. The temperature is then raised 10°C. or to any predetermined level and the remaining mixture is cycled over the evaporator and another fraction is collected. This procedure is followed until the maximum recommended temperature of the evaporator is reached. In some instances some difficulty is experienced due to decomposition at the higher temperatures. Less residence time on the evaporator will help in this situation. The Xylene heated still can be used up to 170°C. The temperature range of the mercury heated still is 150°C to 375°C.

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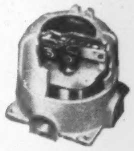

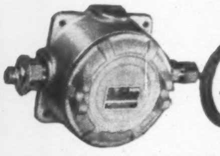

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Before me, a Notary Public in and for the State and county aforesaid, personally appeared Richard Rimbach, who, having been duly sworn according to law, deposes and says that he is the Publisher of *Instruments* and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily, weekly, semiweekly, or triweekly newspaper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933, and July 2, 1946, embodied in section 537, Postal Laws and Regulations, to wit:

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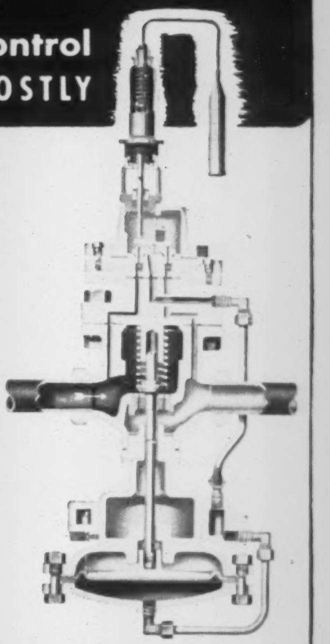

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SELF CLEANING STRAINERS • • LESLIE-TYFON WHISTLES

ELEMENTARY
ENGINEERING
ELECTRONICS
with special reference to
Measurement and Control
By ANDREW W. KRAMER
344 pages 259 illustrations
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INSTRUMENTS PUBLISHING CO.
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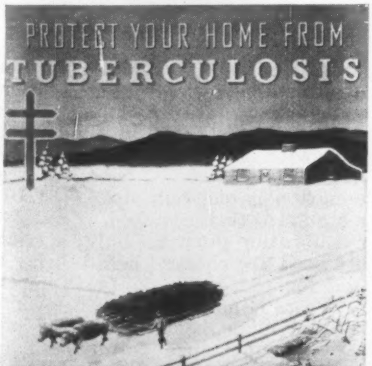
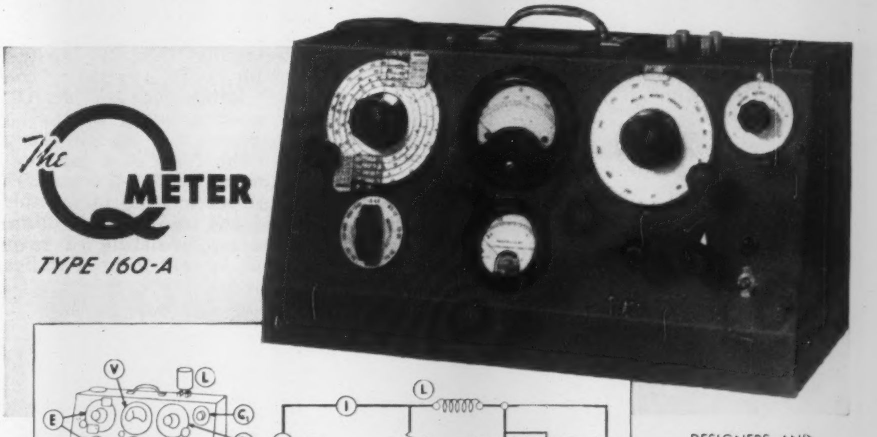


MANY FEATURES IN ONE INSTRUMENT



SIMPLIFIED LAYOUT AND SCHEMATIC OF THE 160-A Q-METER

THE BASIC METHOD OF MEASUREMENT EMPLOYED IN THE 160-A Q-METER
An R.F. oscillator (E) supplies a heavy current (I) to a low resistance load (R), which is accurately known. The calibrated voltage across the load resistance (R) is coupled to a series circuit consisting of the inductance under test (L) and a calibrated variable air capacitor (C_0) having a vernier section (C_1). When this series circuit is tuned to resonance by means of capacitor (C_0+C_1), the "Q" of (L) is indicated directly by the V.T. Voltmeter (V). Variations of this method are used to measure inductance, capacitance and resistance. ***Oscillator Frequency Range:*** **50 kc. to 75 mc. in 8 ranges.** ***Oscillator Frequency Accuracy:*** **±1%, 50 kc.—50 mc.** ***Q-Measurement Range:*** **Directly calibrated in Q, 20-250. Multiplier extends Q range to 625.** ***Capacitance Range:*** **Main section (C_0) 30-450 mmf. Vernier section (C_1)+3 mmf, zero, —3 mmf.**

DESIGNERS AND
MANUFACTURERS OF
THE Q METER
QX CHECKER
FREQUENCY
MODULATED
SIGNAL GENERATOR
BEAT FREQUENCY
GENERATOR
AND OTHER
DIRECT READING
TEST INSTRUMENTS

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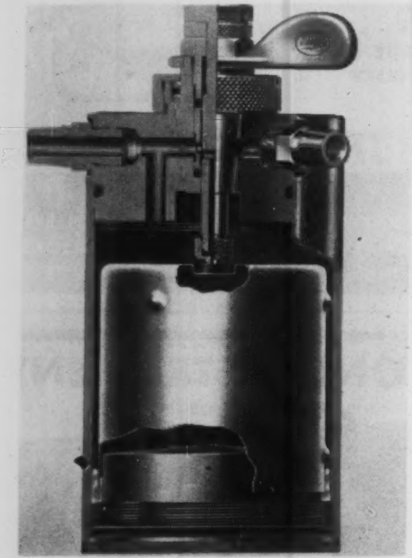
The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 1069

Pressure or Vacuum Controller

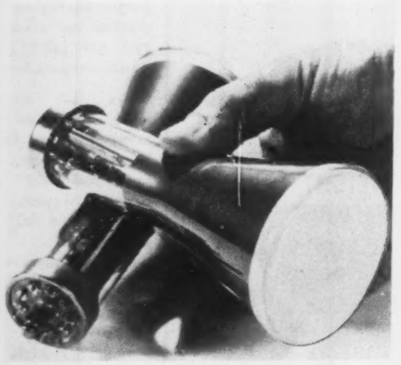
New "Model 5 Industrial Cartesian Monostat" is described as a "revolutionary vacuum and pressure regulator." It operates on the physical principle of the Cartesian Diver (a method new to industry); requires no electrical or mechanical systems or extra equipment; has only to be put in any existing system and set to desired pressure or vacuum without further attention being needed. It will maintain constant pressure or vacuum to within 0.01%. It is said to have all advantages of the glass manostat made by same company, is larger in capacity and has a wider range, higher sensitivity and greater flexibility. New resistant all-metal manostat measures 7½" over-all; diameter 3¼"; weight 6½ lbs.—*The Emil Greiner Co., 161 Sixth Ave., New York City.*



Please mention number 1101 when filling out card

Cathode-ray Tube

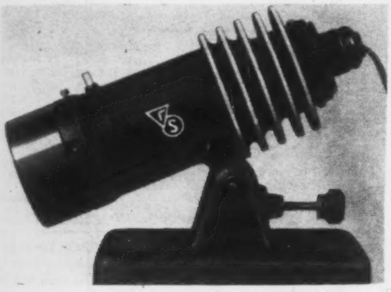
New cathode-ray tube "Type 3QP1" for oscilloscope use is short (6⅛"), has a flat 2¾" face; provides improved electron-optical characteristics, particularly at screen edge; has improved cross-talk characteristics between deflection-plate pairs; utilizes P1 (green) phosphor and has electrostatic focus and deflection. Rated heater drain is 0.3 amps. at 6.3 volts. Interterminal capacitance between 2 and 9 $\mu\mu$f. Under typical conditions, potentials are $E_{B2} = +800$ volts d.c., $E_{B1} = +300$ volts d.c. and E_G (cut-off) $= -35$ volts d.c. Deflection factor $D_1 - D_2 = 168$ volts d.c. per inch and $D_3 - D_4 = 105$ volts d.c. per inch. Modulation requires +25 volts max. to produce 3 ft-L. on a 2" × 2" raster. Line width = 0.025" with a sine wave and E_G set for 75% of cut-off. Under max. oper'g cond., $E_{B2} = +2500$, $E_{B1} = +600$, $E_G = -125$ to $+2$ volts d.c.—*North American Philips Co., Inc., 100 East 42nd St., New York 17, N. Y.*



Please mention number 1102 when filling out card

Photomicrographic Lamp

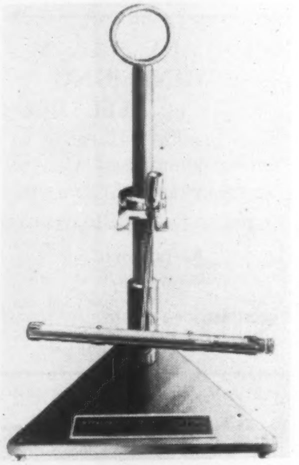
New "Zirconarc" point-light-source is said to enable microscopists to make highest-quality photomicrographs (black-and-white and color) "in less time and with less trouble than ever before." Important feature is new light source developed under an NDRC contract by Electronics Div. of Western Union Telegraph Co. It is called a "concentrated-arc" lamp because activity concentrated upon a small portion of electrode produces a high-intensity light source in the form of a luminous circular spot only 0.037" (< 1 mm.) in diameter. This spot is fixed in position, sharply defined and uniformly brilliant. Condenser system, consisting of seven optical elements, is said to be a radical innovation in design. It collects a 100° cone of light from light source, corresponding to a numerical aperture of 0.77. System is corrected for spherical aberration, coma and color. Optical corrections are such that performance of lamp is said to leave nothing to be desired, even when it is used in conjunction with finest achromatic sub-stage condensers. Extremely short equivalent focal length (16.5 mm.) of condenser system utilizes point source to fullest advantage. Sub-stage condensers of the highest numerical aperture are fully covered with new lamp placed at reasonably close distances. Optical system is rigidly mounted in a barrel which slides for focusing within external housing. Focusing lever is easily accessible and can be locked in any position. A detachable lens for high-power microscopy increases focal length, concentrating illumination into a long, narrow beam. Lenses are coated to minimize loss of light by stray reflection, and flat surfaces of lens barrel are chased to prevent whatever reflection does arise from interfering with optical system. Housing is of cast aluminum mounted upon a cast-iron base for stability. Overall length 10", height 6½"—*Fish-Schurman Corp., 230 East 45th St., New York 17, N. Y.*



Please mention number 1103 when filling out card

Bubble-rise-time Viscosimeter

New "Interchemical Inclined-tube Viscometer" is said to offer wide possibilities in many industries for accurate measurement of viscosity of all clear liquids. Features include: (1) Only one adjustable member, for occasional standardizing. (2) Results obtained on a continuous scale in fundamental units; with an electric timer reading to tenths of seconds, smallest-scale graduation is one centistoke. (3) Only one standard tube required, is employed for calibration purposes only; specimen tubes used are checked before being released for routine work. (4) Temperature errors eliminated when determinations are made beneath surface of a constant-temperature water bath (5) Operator error practically eliminated by averaging multiple readings. Little difficulty in keeping overall error within ±3% for factory control, with unskilled operators. (6) Wide measuring range: from 0.6 to 150.0 stokes with-



t readjustment. However, if majori- of determinations are above 30 okes, apparatus can be set to pro- de results in shorter time intervals.) Time required is low compared to ost other methods. (8) Test speci- en is contained in a closed tube dur- g measurement, obviating evapora- on or chemical reaction errors. Orders ould specify whether instrument is be calibrated for measuring viscosi- es from 0.60 to 30.0 stokes or 30.0 150.0 stokes. — *Henry A. Gardner aboratory, Inc., 4723 Elm Street, ethesda 14, Md.*

Please mention number 1104 when filling out card

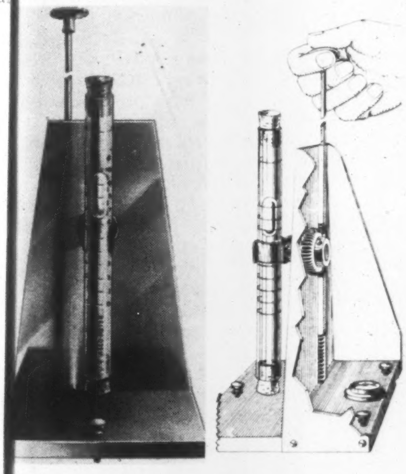
High-speed D-c. Relay

New version of "Millisec Relay" (so lled because operating time is one illisecond or less) is made with a ielded coil for those applications here shielding is desired between coil d contacts. It is assembled in a stand- rd metal radio tube container but its eration is mechanical and not elec- onic. Previous model was fully de- ribed and illustrated in *Instruments,* an. 1946, page 60. — *Stevens-Arnold, c., 22 Elkins St., South Boston 27, ass.*

Please mention number 1105 when filling out card

Bubble-rise-time Viscosimeter

New "Gardner Visco-Meter" permits xtremely rapid kinetic-viscosity determinations over exceptionally wide anges. Accuracy is within 2% at low

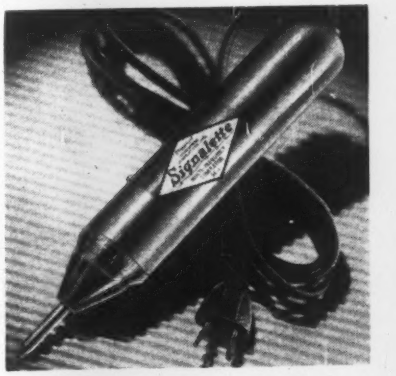


iscosities (better at high viscosities) ut distinctive characteristic is a con- ination of design features which save ime in measuring, filling, cleaning, tc. Precision-bore Pyrex tube is stop- ered at both ends (permitting quick ramrod" cleaning), is graduated in en equal parts so that, with extremely iscous materials, bubble may be timed ver any fraction of total distance. urves of viscosity vs. temperature an therefore be plotted in minimal ime and computation errors practical- eliminated because seconds=stokes. ompact size fits most water baths. o calibration or recalibration is ever ecessary, nor are reference charts or orrection curves needed. Small (13 c.) sample suffices. New instrument especially adapted to transparent oils, butadiene polimers, cellulose dopes, resin or chlorinated rubber solutions, etc.—*Henry A. Gardner Laboratory, Inc., 4723 Elm St., Bethesda 14, Md.*

Please mention number 1106 when filling out card

Signal Generator

New "Signalette" pocket-size signal generator producing r-f., i-f. and a-f. frequencies simultaneously from approx. 2500 cps. through 20 Mc., is said



to perform all necessary functions of large high-priced generators and to speed up radio servicing routines. Operating on 110 volts a.c. or d.c., it has a fundamental frequency of approx. 2500 cps. modulated by 60-cycle supply when used on a-c. line; modulation is not present when used on d-c. supply. Approx. 9¼″ long by 1½″ diameter and weighing 9 oz., "Signalette" is convenient to use, has an adjustable output attenuator and is completely isolated from power source for testing receivers. Separation of 2.5 kc. between successive harmonics facilitates receiver testing.—*Clippard Instrument Lab., Inc., 1125-33 Bank St., Cincinnati 14, Ohio.*

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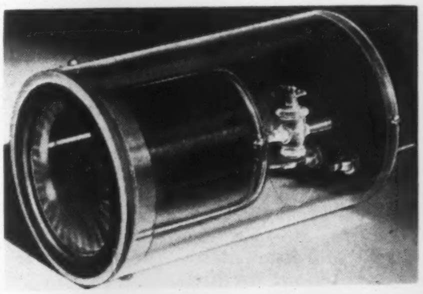
Geiger Tube

New "410-A" Geiger tube is said to be of special interest to radioactive carbon users. Its characteristics include: For alpha particles from

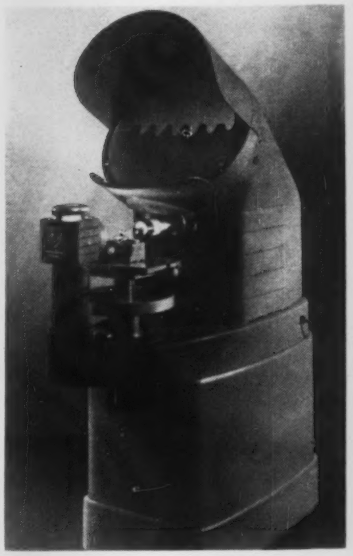


uranium, 25% of total disintegrations. For soft beta such as from C^{14}, Fe^{59} and S^{35}, 36% of total disintegrations. (These efficiencies with windows 1.2 to 1.4 mg./cm.^{2}, which is minimum recommended thickness.) In Geiger-Muller region, background of approximately one count per second when shielded. Said to be excellent also for hard beta and gamma; designed for satisfactory life of 10^9 counts. Unsupported mica window 2½″ diameter; thicknesses available from 0.7 to 2.3 mg./cm.^{2}.—*Cyclotron Specialties Co., Moraga 11, Calif.*

Please mention number 1108 when filling out card

Optical Projection Comparator

New "AO Optical Projection Comparator" as illustrated is suitable for the production line but can, by addition of micrometer stage and protractor, be converted for finest laboratory uses. Features include: (1) parfocal and parmagnified lens systems factory adjusted for correct magnification and focus; (2) pre-focused and pre-centered bulb replaceable without adjustments; (3) no heat in operator's face; (4) high-speed factory-adjusted condensing system; (5) interchangeable magnifications of 10×, 20×, 31.25×, and 62.5× in quick-change bayonet mounts; (6) screen has 16″ diameter image area and even illumination; (7) distortion-free images for measuring accuracy; (8) coated lenses; (9) in-

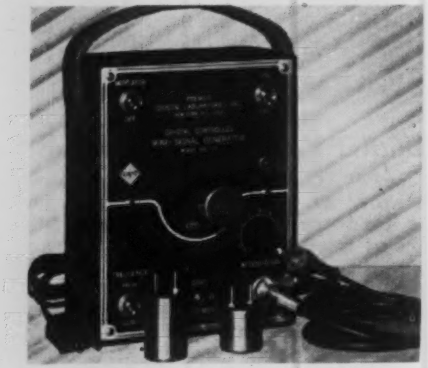


stant finger-tip focusing; (10) colored light filter selected for maximum contrast and eye comfort; (11) work stage has 4″ vertical travel and accommodates lock-fast cams of most standard fixture bases; (12) first surface mirror factory adjusted, then sealed in dust-free, oil-free, tamperproof chamber, which also protects inner surfaces of lenses and viewing screen. New projector is said to be easily moved about plant on retractable roller-bearing casters.—*Engineers Specialty Div., 1919 East 19th St., Cleveland 15, Ohio.*

Please mention number 1109 when filling out card

Signal Generator

New "Model No. 117 Mini-Signal Generator" provides, with appropriate crystal, any frequency from 100 kc. to 10.8 Mc., with harmonic operation for higher frequencies; uses any 110-volt power supply, a-c. or d-c. Instrument is especially suitable for roving inspection in assembly departments, for field checking of communications equipment, for setting band limits, and aligning



sets on the test bench. It produces an r-f. signal modulated by an a-f. of approx. 400 cycles, under the control of a continuously-variable attenuator and an off-on switch. It uses Premier PL-100 wire-mounted crystals made to ±0.05% precision. Instrument draws 17 watts, weighs 3¼ lbs. measures 3″ × 5″ × 7″ and comes equipped with a 6-foot cord and 53″ leads with insulated clips. — *Premier Crystal Laboratories, Inc., 57-67 Park Row, New York 7, N. Y.*

Please mention number **1110** when filling out card

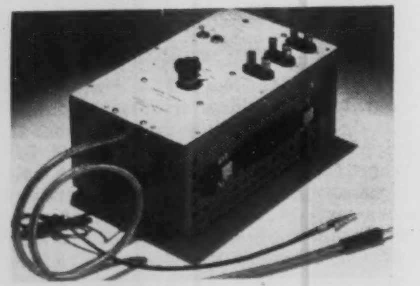
100-lb. Tensile and Compression Tester

New 100-lb. Universal Tester handles specimens in tension and in compression. Announcement states that "selling price is actually set under $50." Specifications include: capacity, 100 lbs. in 1-lb. increments; accuracy, 2% of indicated load; dial, 5″ O.D.; length, 15″ including handwheel; width, 5″ across dial, 2⅝″ across body; height, 3⅛″; weight, 3¼ lbs.; stroke, 3″ (1″ min. and 4″ max. daylight opening); grip face, ¾″ × 1¾″, non-serrated. Tester can be hand-held for operation, cannot be injured by accidental overload or shock recoil, will handle tensile specimens 1¾″ wide × ⅛″ thick.—*W. C. Dillion & Co., Inc., 5410 West Harrison Street, Chicago 44, Illinois.*

Please mention number **1111** when filling out card

Instrument Amplifier

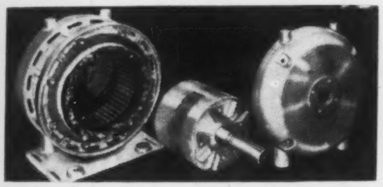
New "Model 102 Phantom Repeater" is a new type of instrument designed to facilitate electrical measurements. It features a circuit which has an extremely high input impedance at ends of test leads, coupled with an instrument amplifier having a low output impedance. Typical oscilloscopes and most electronic voltmeters have input impedances of 0.5 to 2 megohms shunted by 15 mmf. to 40 mmf.; 10 mmf. to 60 mmf. or more are added by the test leads. Characteristics of a high-impedance circuit, such as a pentode amplifier with a one-megohm plate load resistor, are appreciably changed when either instrument is connected to it. "Model 102," connected between unknown circuit and test instruments, permits both the voltmeter and oscilloscope to be used simultaneously. Reason for term "phantom" is that input impedance of 200 megohms shunted by 5.5 mmf. is sufficiently large that it is not a tangible factor in considering the operation of most circuits being tested. "Repeater" because entire system is linear: input voltage is repeated exactly at output without changes in phase or amplitude, except increases in level selected by the operator. "Model 102 Phantom Repeater" has wide application in audio and ultrasonic work. It is said to provide higher accuracy, neater and simpler set-ups, and a means for making measurements which were otherwise not possible. Cabinet dimensions 10¼″ × 6⅛″ × 4½″; weight approx. 11 lbs. — *Keithley Instruments, 1508 Crawford Road, Cleveland 6, Ohio.*



Please mention number **1112** when filling out card

Electric Generator

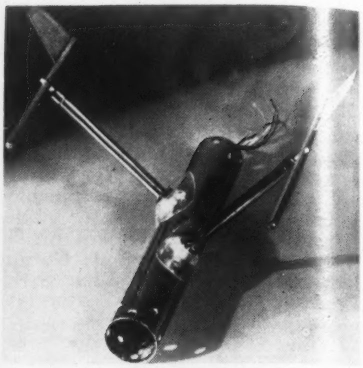
New "Kober Type" permanent-magnet generator (developed during war and used by U. S. Army) utilizes permanent magnets in a new way, shielded to avoid loss of magnetism; is said to be capable of achieving standards of performance previously unattainable. Elimination of exciters, slip rings, commutators, brushes, etc., minimizes maintenance cost. Overloads and short-circuits that would permanently impair ordinary machines are said to leave this generator unaffected. Output voltage is practically independent of temperature. New machine is explosion proof. For instrumentation applications which require control of terminal voltage, an integrally-mounted automatic voltage compensator is available. Kober Generator is available in 60-cycle and 400-cycle types, single-phase and three-phase, in outputs ranging from 300 watts to 30 kilowatts.—*Kober Electric Co., Arlington, Virginia.*



Please mention number **1113** when filling out card

Pitch and Yaw Indicator

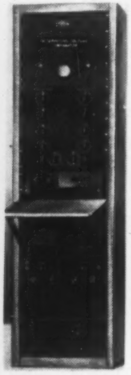
New "Autoflight" angle of pitch and yaw vane transmitters attach to standard Pitot tube mast; vanes indicating pitch and yaw are geared to "Microtorque" dragless position transmitters (requiring only 0.003 oz.-in. torque) that convert mechanical movement of vanes into a d-c. or an a-c. signal. This signal is read visually on instrument panel of airplane, or transmitted to ground from pilotless aircraft. Each vane has its own Microtorque." Accuracy of "Microtorques" is said to exceed accuracy gearing linkage. Electrically, new vane transmitters fit resistance specifications ranging from 100 ohms to 20,000 ohms. Resolution of instrument is better than ¼ of a degree in range of resistance over 5,000 ohms.—*G. M. Giannini & Co., Inc., Pasadena, Calif.*



Please mention number **1114** when filling out card

Alternating-voltage Comparator

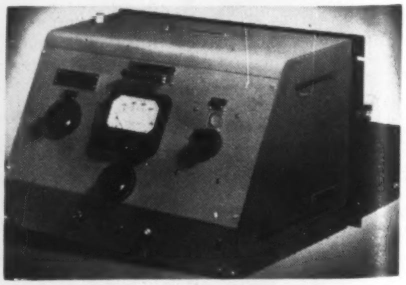
New Alternating Voltage Comparator (originally developed during war to make possible high accuracy of fire-control computers) functions at any frequency between 50 and 1.250 cps., permits laboratory measurement of a-c. voltage and phase angle to be made with an accuracy of 1 part in 50,000 (0.002%). Applications include measurement of vectorial ratios essential to computer development; transformation ratio of transformers and networks; power factor of transformers; power factor and *Q* of resistors, capacitors and inductors; capacitance or inductance by reference to a suitable standard; ratio of two currents; and power factor of a-c. machines.—*Arma Corp., 254—36th St., Brooklyn 32, N. Y.*



Please mention number **1115** when filling out card

Capacitance Bridge

New "Type 125" capacitance bridge suitable for measurement of capacitance in multi-electrode systems, including vacuum tubes, provides a total range of 0 to 100 μμf. through use of



One bubble doesn't make
a beauty bath

BUT a gal's lucky to get even one in some parts of the country. The water is so hard it's necessary to use water softeners. The operation of many softeners is timed with Telechron synchronous electric motors.

This application is typical of the unusual jobs being found every day for these versatile motors. They have been used successfully in clocks and timing devices for 25 years—and more. They have given dependable service in automatic timing, switching, recording and control equipment. Chances are a Telechron motor is the answer to your own needs.

These accurate, self-starting motors can be adapted to complicated control mechanisms as readily as to simple switches. They reach rated speed almost instantly and operate in perfect synchronism on all commercial frequencies . . . *can't run faster or slower*. Torque ratings are conservative. Precision building and Telechron's exclusive sealed-in oiling system assure years of accurate service.

With a Telechron motor, you get all the advantages of pioneering research and engineering leadership. For over 25 years, Telechron has been the largest producer of synchronous electric motors. And every Telechron motor is Underwriters Laboratories approved under reexamination service. Telechron application engineers will be glad to talk over your needs. Address Motor Advisory Service, Dept. B, Telechron Inc., Ashland, Massachusetts.

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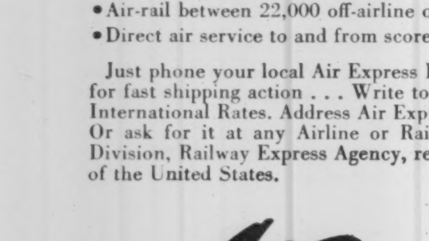

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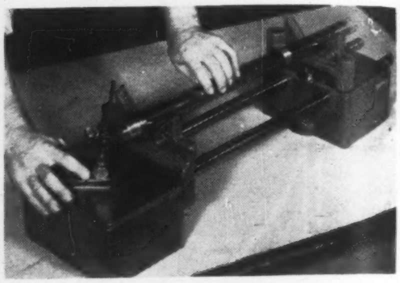
Machine parts (75 lbs.) in Chicago were needed by a bottling works in Dallas *fast.* Picked up 10 AM the 6th, delivered same day at 5:05 PM. 795 miles, Air Express charge only $18.42. Other weights, any distance, similarly inexpensive and *fast.*

five multipliers and measurement at 465 kc. Direct capacitance accuracy of 1% and direct conductance accuracy of 10% are provided when calibrated with standards of commensurate accuracy. Bridge consists of three separate sections including r-f. signal generator and power supply; r-f. amplifier detector and VTVM; and associated switches, controls and 500-microampere indicator for bridge balance. Ground-to-lead or jig capacitance may be tuned out when combined values do not exceed 25 μμf. Bridge rated 45 watts, 110-120 volts, 50-60 cycle a.c.; weighs 50 lbs.; measures 19" long and 12¼" high.—*Electronics Div., Sylvania Electric Products Inc., 500 Fifth Avenue, New York 18, N. Y.*

Please mention number 1116 when filling out card

Concentricity-checking Instrument

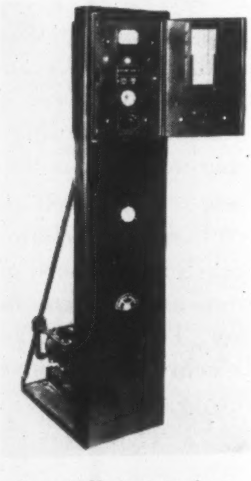
New "V-Liner" is an improved version of "V-Liner" fully described, with two illustrations, as the first item in the New Instruments Department of *Instruments*, Dec. 1946, page 748.—*Swanson Tool & Machine Products, Inc., 814 East Eighth St., Erie, Penna.*



Please mention number 1117 when filling out card

Gas Alarm System

New improvements are announced in "Remote-head Type Continuous Combustible Gas Alarm System" fully described in Feb. 1946 *Instruments*, page 105. To forestall tampering, a cover has been added to control cabinet. Even when cover is closed and locked, external buttons are accessible to silence audible warning signal and to put system back in operation after vapor-air concentration is below alarm point setting. Transparent words in cover become illuminated when their

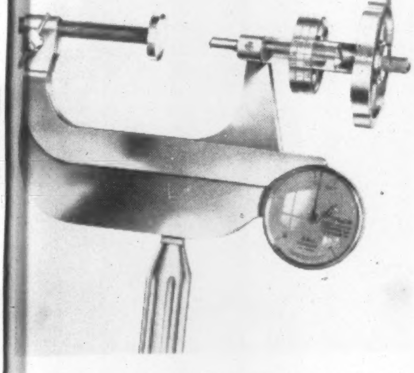


respective relays close: ALARM and APPLIANCE light up when alarm point setting is reached; TROUBLE ANALYZER CIRCUIT lights up when a filament blows out or an "open" circuit occurs in analyzer circuit. A buzzer also gives audible warning. If trouble develops in pump, TROUBLE SUCTION PUMP becomes visible. A small fluorescent bull's-eye under indicating instrument remains lighted as long as current is on. —*Davis Emergency Equipment Co., Inc., 45 Halleck St., Newark 4, N. J.*

Please mention number 1118 when filling out card

Portable Hardness Tester

New "Model 4" portable hardness tester is exactly like "Model 1" fully described in *Instruments*, Jan. 1947, page 70; March 1947, page 222; except that opening is 4" instead of 1" and weight is 3 lbs. instead of 2 lbs. Weight of complete outfit in wooden box with test blocks, penetrators, anvils and Rockwell conversion chart, 8 lbs. —*Ames Precision Machine Works, Waltham 54, Mass.*



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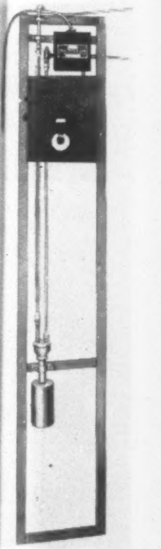
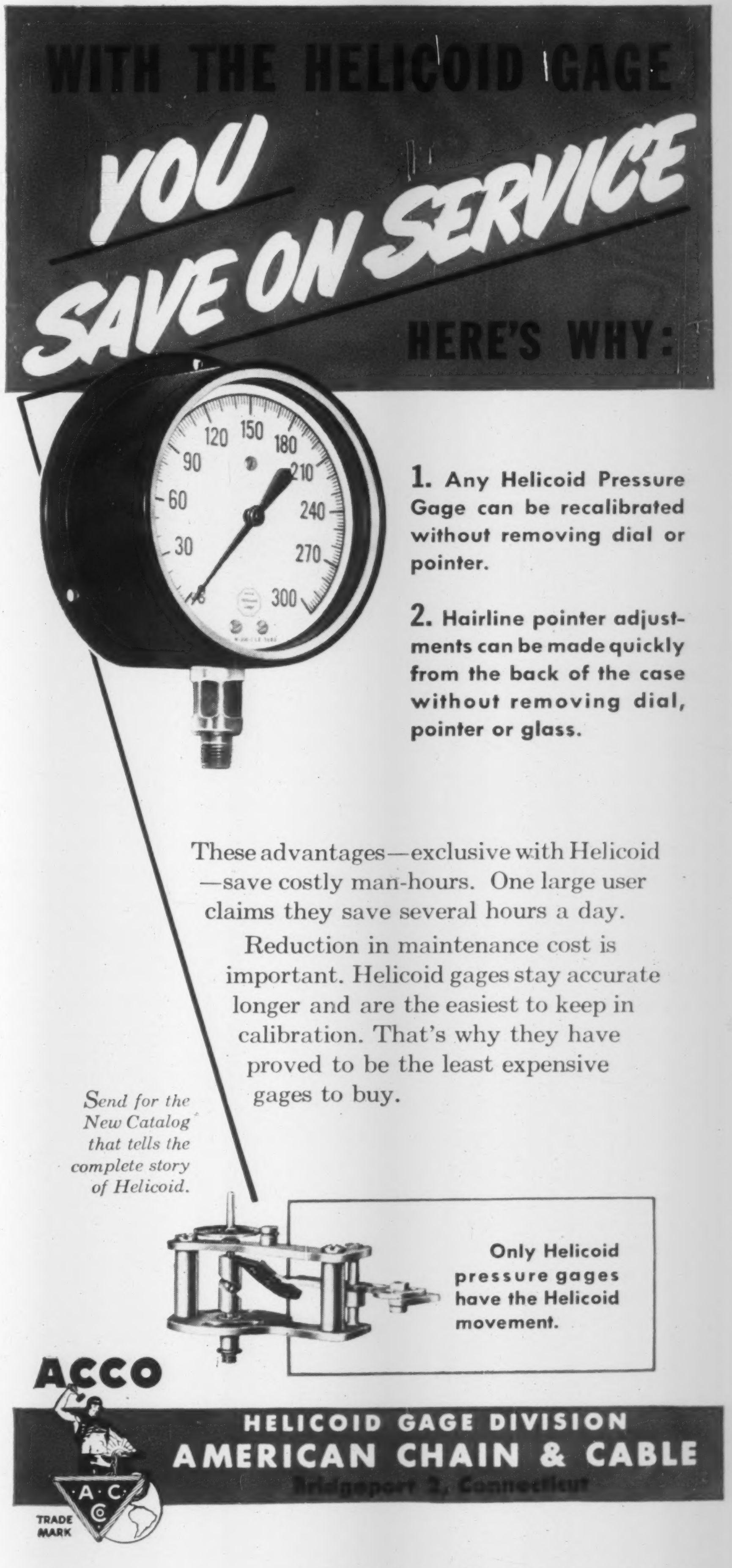
Gas Alarm System



New "Thermalo Gas Detector" safeguards gas-fired processing equipment throughout idle periods as well as during combustion cycles. It detects unburned gas from leaky or carelessly - closed valves, or incomplete combustion; indicates on a dial degree of concentration; and, whenever a predetermined concentration well below danger point is reached, operates an alarm or a control to shut off a gas valve in supply line. It it equally effective for mixtures of flammable gases with inert gases, and for air - gas atmospheres. Gas detector cells are mounted at convenient points for automatic and continuous sampling of gases. During normal operation a green light on control box shows constantly; whenever unburned gas reaches a predetermined concentration a red light gives a permanent signal (and an automatic gas



WITH THE HELICOID GAGE

YOU SAVE ON SERVICE

HERE'S WHY:

1. Any Helicoid Pressure Gage can be recalibrated without removing dial or pointer.

2. Hairline pointer adjustments can be made quickly from the back of the case without removing dial, pointer or glass.

These advantages—exclusive with Helicoid —save costly man-hours. One large user claims they save several hours a day.

Reduction in maintenance cost is important. Helicoid gages stay accurate longer and are the easiest to keep in calibration. That's why they have proved to be the least expensive gages to buy.

Send for the New Catalog that tells the complete story of Helicoid.

Only Helicoid pressure gages have the Helicoid movement.

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HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE
Bridgeport 2, Connecticut

TRADE MARK

NTH DEGREE ACCURACY

... ONE INCH TO ONE MILE!

Precision Made Bourdon Gauge Tubing meets and beats most exacting requirements ... performance tests.

Nth DEGREE LABORATORY CONTROL

"Precision Control" safeguards absolute accuracy of size of tube and wall thickness ... plus the development of exact uniformity of the structure of the metal so essential to long life of pressure spring tubing.

Nth DEGREE HEAT TREATING

"Precision Control" in heat treating is achieved in exclusive bright annealing, atmospherically controlled furnaces. The precision exercised in attaining metallurgical specifications makes possible a tubing which is outstandingly high in fatigue resistance.

Nth DEGREE ACCURACY IN TESTING

"Precision Controlled" inspection carefully checks to the Nth degree every inch of tubing produced. Precision produces Bourdon Gauge Tubing to specifications with any non-ferrous metal. It is available in all bourdon shapes, in cut or random lengths. Obtainable on good delivery.

WHEN PRECISION COUNTS ... COUNT ON PRECISION

Aluminum alloy instrument tubing to exact specifications ... preformed tubing to suit your needs ... Coaxitube—the metal shielded wire for a 1001 electronic uses. Write for complete catalog today.

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PRECISION

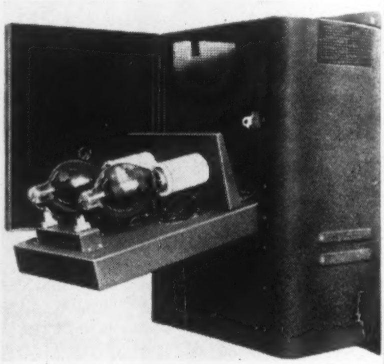
Factory: 3824-26-28 TERRACE STREET, PHILADELPHIA, PA.

shut-off valve may operate as well until affected area is purged. Failure of current or of any part of mechanism operates alarm (or a gas shut-off) automatically. Sensitivity is stated as follows: "Even slight variations from the correct fuel mixture are registered on the dial." In most applications no motor or aspirator is needed. For operation of detector in the presence of flammable gases, a "negligible amount" of current is required—either d.c. or a.c. "Thermalo Gas Detector" is obtainable for any specified type of gas fuel, manufactured, natural, mixed, or bottled gas.—*Jabez Burns & Sons, Inc., Eleventh Avenue at 43rd Street, New York 18, N. Y.*

Please mention number **1120** when filling out card

Electronic Rectifier

New "Series WR 40-50-60 Electronic Rectifier" is said to be especially useful for small d-c. motors and other applications where direct current is required,

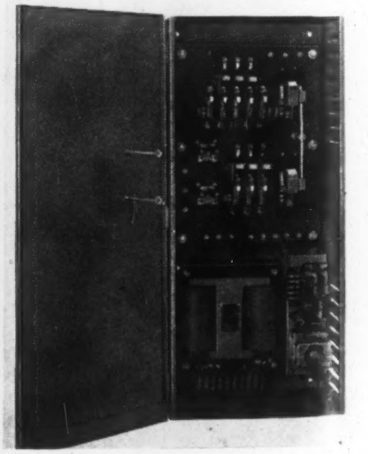


replacing m-g. sets where power from 750 to 2000 watts is desired. Voltage is 115/230 d.c.-115/230/460 a.c. New design features better ventilation and easier accessibility to parts. Control panel tilts forward for servicing. Rectifier is 18″ wide, 12″ deep, 24″ high.—*Weltronic Company, Dept. K, 194 W. Eight Mile Road, Detroit 19, Mich.*

Please mention number **1121** when filling out card

Automatic Motor Starters

New "Bulletin 4051" a-c. automatic motor starters are of non-reversing autotransformer type designed for use with single-speed two- or three-phase squirrel-cage induction motors; are ad-

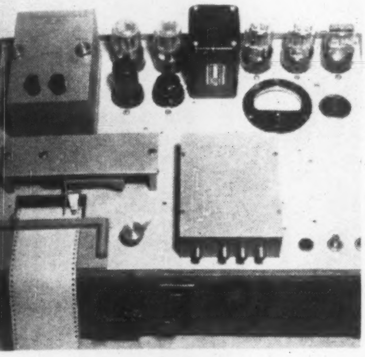


vantageously used where inrush starting currents must be reduced or where motor starting torque requires adjustment. Drip-proof enclosed starter is conveniently arranged in three accessible and removable sections: contactor panel, timer panel and multi-tap autotransformer. All line, load and control terminals are completely accessible. Adjustable time limit acceleration, overload protection, mechanical and interlock protection and adjustable taps on autotransformer are provided on all starters. Units are available in standard sizes for use with squirrel cage induction motors up to and including 100 hp, 550-volts, 60-cycles.—*Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.*

Please mention number 1122 when filling out card

Power Level Recorder

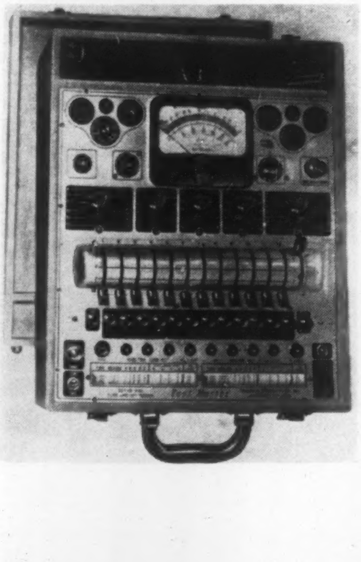
New "Model HPL" high-speed power level recorder (re-design of maker's "Model PL" recorder) has many distinctive mechanical advantages over previous model, such as three push-button-operated paper speeds and easier accessibility to recording mechanism, scriber and potentiometer train. Electric circuit, too, is improved. Price of "Model HPL" is not increased over that of "Model PL."—*Sound Apparatus Co., 233 Broadway, New York 7, N. Y.*



Please mention number 1123 when filling out card

Tube and Set Tester

New "Series 10-20 Electronamic Test Master" includes "Precision Electronamic Tube Performance Test Circuit" plus a complete push-button operated a-c.-d-c. set tester. Test circuit features



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REVOLUTIONS PER MIN
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JAMES G. BIDDLE CO
PHILADELPHIA, PA
TYPE TS

"Frahm" RESONANT REED TACHOMETERS

Check THESE ADVANTAGES

- **ACCURATE,** because the tuned reed is a natural resonant indicator.
- **DEPENDABLE,** because permanent calibration is a natural characteristic of tuned reeds.
- **STURDY,** because there are no delicate pivots, jewels or moving parts.

and these . . .

EASY-TO-READ vibrating reed-tips form a clearly defined pattern.

LITTLE MAINTENANCE is a result of simple, sturdy construction.

LOW INPUT POWER is sufficient to actuate the reed comb.

OPERATE IN ANY POSITION without affecting accuracy.

ORDINARY ROOM TEMPERATURE VARIATIONS HAVE LITTLE EFFECT on calibration.

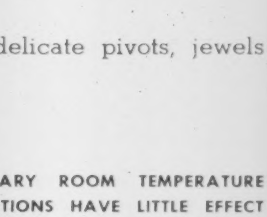
OPERATE WITHOUT DIRECT CONTACT with moving parts under test.

EASY TO OPERATE . . . may be held against or mounted on machine.

Frahm Resonant-Reed Tachometers in round, rectangular and miniature types are available in ranges between the limits of 900 and 100,000 rpm or vpm. Made for permanent mounting on turbines, generators, motors, blowers, centrifugal pumps, diesel-electric installations, etc. Made also in hand types for a wide variety of uses. Write today for Bulletin 1810-I.

"FRAHM" Resonant-Reed FREQUENCY METERS

. . . operate on the same unique principle as Frahm Tachometers except that reed vibration is produced electrically instead of by direct mechanical contact. Available in switchboard, miniature and portable types for ranges between 15 and 500 cycles per second. To meet special requirements, we are equipped to build instruments for measuring frequencies as high as 1400 cps. For complete information write today for Bulletin 1770-I.



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ELECTRICAL & SCIENTIFIC INSTRUMENTS
1316 ARCH STREET • PHILADELPHIA 7, PENNA.

TYPE B
HIGH PRECISION
POTENTIOMETER

This general purpose potentiometer, incorporating a number of notable refinements in potentiometer design, is widely used for precise temperature measurements including thermocouple standardization, for meter calibration, for checking portable potentiometers and for other critical measurements of DC potentials requiring exceptionally high accuracy. Distinctive features include:

1. Three ranges: 0 to 1.6 volts, 0 to 160 millivolts and 0 to 16 millivolts.
2. Three reading dials—effective scale length of approximately 175 feet for each range. Readings easily estimated to within one part in 100,000 of full-scale ranges.
3. Subpanel switch and slidewire construction for protection of contacts from dust and corrosive fumes.
4. Special provisions to minimize parasitic thermal emf's—including automatic compensation of slidewire thermals and gold contacts in galvanometer key.
5. Exceptional convenience in reading and adjustment.
6. Solid and substantial construction for many years of trouble-free service.

Thoroughly proven by practical application in exacting research investigations for nearly fifteen years. Described in Bulletin 270.

Rubicon galvanometers suitable for use with the Type B Potentiometer are described in Bulletin 320.

PORTABLE PRECISION POTENTIOMETER

A two-dial instrument with built-in standard cell, galvanometer and battery, available in a variety of ranges for laboratory, plant and field applications. Described in Bulletins 270 and 270A.

OTHER
RUBICON INSTRUMENTS

Galvanometers • Resistance Standards • Wheatstone, Kelvin and Mueller bridges • Evelyn Photoelectric Colorimeter for precise chemical analysis • Automatic Recording Photometric Analyzers for NO and H2S • Magnetic Permeameters • Shorted-turn Coil Testers • Other equipment involving precise measurement of electrical quantities.

RUBICON COMPANY
Electrical Instrument Makers
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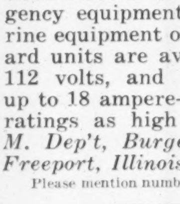
direct facilities to accommodate up to twelve elements and tests all standard receiving and low power transmitting tubes. It has 34 a-c. and d-c. ranges, plus complete radio A, B and C battery test facilities which reveal battery condition under dynamic load test. New instrument is particularly suited for industrial-electronic maintenance service and installation. All standard set testing functions are available at two polarized tip jacks. All circuits are insulated from power line. Resistors are 1% wirewound, matched and metallized. All ranges are self-contained, without any additional panel controls. "Series 10-20" is available as a portable instrument ("10-20-P"); for counter ("10-20-C") or rack mounting ("10-20-PM"). —*Precision Apparatus Co., Inc., 92-27 Horace Harding Blvd., Elmhurst, L. I., N. Y.*

Please mention number 1124 when filling out card

High-power Batteries

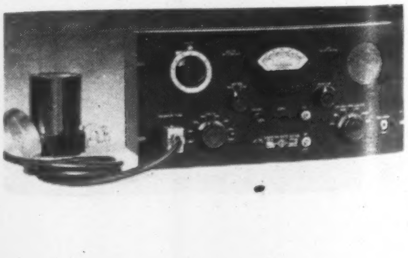


New "A. M. Power Units" are said to offer particular advantages where high power is required, and weight and space must be conserved. Standard units can deliver up to 30 watts per cubic inch and 360 watts per pound. It is said that "A. M. Power Units" can be stored for years without deterioration. Voltage is maintained nearly constant throughout life of units. They are supplied in dry form but are readily activated by brief immersion in water. Units are particularly useful for airborne electronic equipment, have other applications such as use in instruments, emergency equipment, light units, and marine equipment of various kinds. Standard units are available rated at 1.5 to 112 volts, and with capacity ratings up to 18 ampere-hours, and with power ratings as high as 2.8 kilowatts.—*A. M. Dep't, Burgess Battery Company, Freeport, Illinois.*

Please mention number 1125 when filling out card

Counting-rate Meter for Radioactivity Measurements

New "Type 1500-A Counting-Rate Meter" indicates directly in counts per minute the rate at which nuclear transformations occur in radioactive materials. Range of operation is from 5 to 20,000 counts per minute. Among features: aural monitor; regulated and adjustable high-voltage supply (400 to 2,000 volts); quenching circuit that permits use of either a self-quenching or a non-self quenching Geiger-Mueller counter; ease of operation; provision for operating a 5-ma. pen-and-ink re-

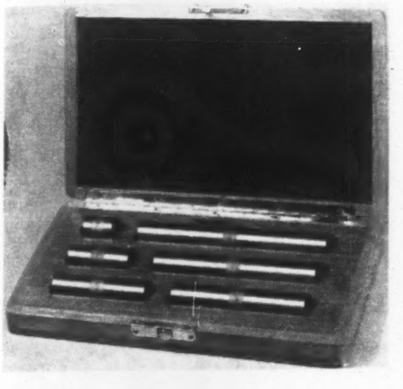


corder so that presence of an operator is not required while data are being accumulated. Geiger-Mueller counter tube is mounted, with its quenching circuit, in a probe at end of a four-foot cable. For easy interchangeability and short leads, instrument is designed primarily for use with a counter that has a four-prong tube base. Other designs of counters can be used, however, since connections to the socket can easily be made. Beta-ray and gamma-ray counters are available; other types will be available. Full-scale values of 200, 600, 2,000, 6,000, and 20,000 counts per minute are provided. Accuracy is ±3% of full-scale on all ranges. "Type 1500-A" is supplied for table or bench mounting; can be converted for rack mounting. Panel dimensions 19" × 8¼". Depth behind panel 13". Net weight 38½ lbs., including probe.—*General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

Please mention number 1126 when filling out card

Micrometer-setting Gage Blocks

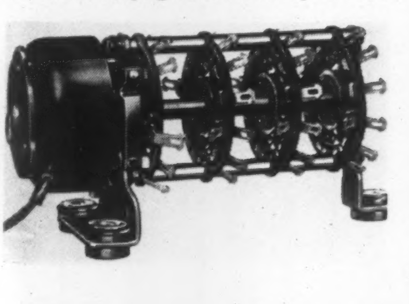
New "No. M21" set of "Microgages," designed for setting large micrometers, includes 1", 2", 3", 4", 5" and 6" "Microgages" ⅞" in diameter. "Microgages" up to 1" are held within a tolerance of +12 and −8 microinches. The 2", 3", 4", 5" and 6" "Microgages" are held within a total tolerance of 15 microinches per inch of gage length. New set will make combinations up to 21"; is furnished in a solid mahogany case.—*The Van Keuren Co., 176 Waltham St., Watertown, Mass.*



Please mention number 1127 when filling out card

Rotary-solenoid-operated Circuit Selector Switch

New multiple circuit selector switch is a new application of "Ledex Rotary Solenoid" fully described in Sept. 1945 *Instruments*, page 668. Rotary solenoid



Shallcross
for
out-of-the-ordinary
Switches
Shallcross Switches offer a broad assortment of finely made, low contact resistance rotary selector switch types for exacting applications. Numerous standard types in single and multi-section units up to 180 contacts can readily and economically be adapted to specific requirements.

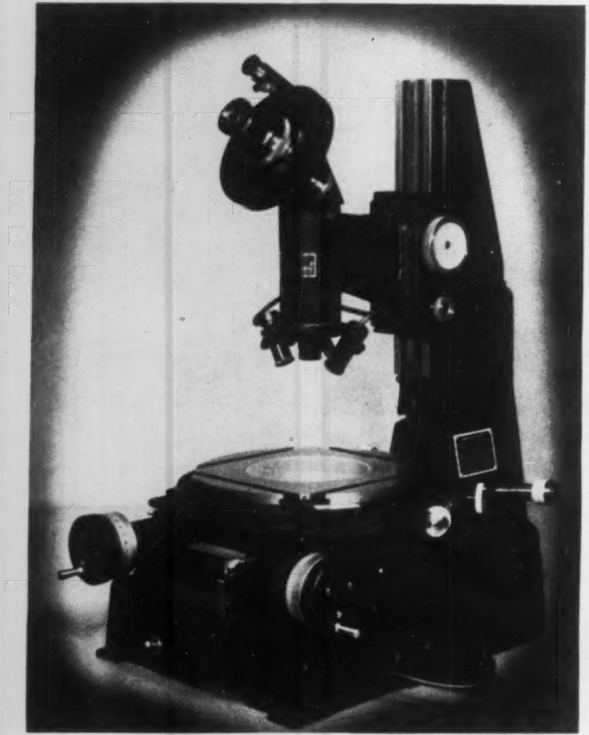
Write for Switch Bulletin C-1 and C-2

AKRA-OHM PRECISION RESISTORS
14 Standard Types. 50 available special designs.
HIGH-VOLTAGE TEST EQUIPMENT
1.5 to 200 KV
BRIDGES
Wheatstone, Kelvin-Wheatstone, Percent Limit and Fault Location Types
DECADE BOXES
1 to 7 dial types, 0.1 to 11, 111, 110 ohms
VOLTAGE DIVIDERS (DECADE POTENTIOMETERS)
Voltage ratios 0.0001 to 1.0
ATTENUATORS & CONTROLS FOR COMMUNICATION EQUIPMENT
LOW RESISTANCE TEST SETS
From 200 micro-ohms to 100 ohms

SHALLCROSS MANUFACTURING COMPANY
DEPT. IS-117, COLLINGDALE, PA.

Gaertner

TOOLMAKER MICROSCOPE
with
ROTARY STAGE



Especially useful for checking gear tooth spacings, laying out cam contours, and in performing numerous other precision measurements in either rectangular or polar coordinates.

Stage Rotation .... 360°
Direct reading to .... 1 minute
Coordinate Range .... 4 x 2 inches
Direct reading to .... 0.0001 inch

Write for Bulletin 147-14

THE GAERTNER SCIENTIFIC CORP.
1211 WRIGHTWOOD AVE., CHICAGO 14, U. S. A.

AUTOMATIC
BECK
CONTROLS

Non-coasting
BECK MECHANISMS
for Precise Automatic Control

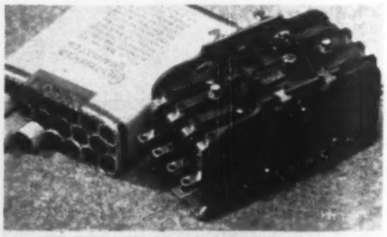
HAROLD BECK CO., 3642 N. SECOND STREET, PHILADELPHIA 40, PA.

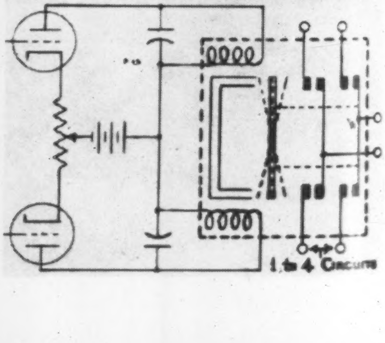
is converted to a rapidly-oscillating motor by means of a commutating switch synchronized to close and open respectively at start and end of energized stroke of solenoid, a spring providing for return stroke. Through an end-engaging type ratchet, the oscillating motion drives rotor assembly of a gang of multiple circuit electric switches. "Homing" contacts in a switch section can be arranged to stop rotation at desired positions, and other contacts provide for indication of circuits selected. Assembly is said to be powerful and rugged; can readily be incorporated in industrial instrumentation requiring selection of electrical control circuits. Operation can be explained by automobile-radio application: operator simply touches one station-selector button and solenoid drives rotor assembly to position which has been established for this station. Solenoid units are available in various values of stroke up to and including 95°. They operate on direct current. When necessary, manufacturer furnishes a compact solenium-type rectifier as an accessory. — *G. H. Leland, Inc., 12 Webster St., Dayton 2, Ohio.*

Please mention number **1128** when filling out card

Three-position Relay

New "Type 6FX8A" 3-position or null indicating polarized relay is said to be an improved device for relay-terminated control circuits and servomechanisms. It has a flexible contact structure of up to four normally open circuits for each polarity (total of eight). When coil is provided with two opposed windings for use in a push-pull cutout circuit, minimum differential power requirements are approx. 0.005 watt per contact pole, and operation is unaffected by variations in stand-by current. With a single-wound coil, about 0.0025 watt is needed per contact pole. Armature, which is almost exactly balanced, has snap-action centering or detent, does not move gradually with increasing coil current. About 25 grams of force at contacts is available from an input of 0.005 watt, and a similar force for holding central or null position, with input balanced or zero. Magnetic circuit being polarized, force increases directly with current up to nearly 200 grams. High forces and balanced armature

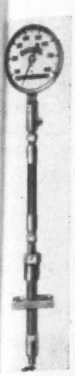




give relay exceptional ability to withstand shock and vibration. Contacts, which may be ganged in double break or paralleled pair arrangement, are rated at 5 amps., 110-v.a.c. nominal each. Open or hermetically-sealed types are offered.—*Sigma Instruments, Inc., 70 Ceylon St., Boston 21, Mass.*

Please mention number 1129 when filling out card

Diesel Compression Tester

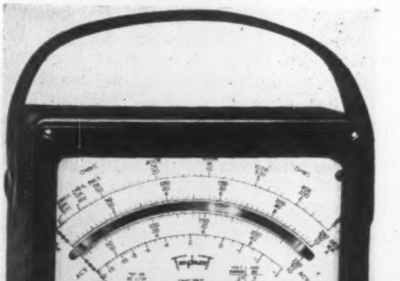


New Diesel compression tester is simple to use: Fuel injector is removed from cylinder to be tested and adapter of tester is inserted into injector opening. (Adapter is designed to be held in place by the same means used for holding injector.) Engine pressure is communicated to 3½" dial gage through a "cartridge-sealed" trapping device in adapter; pointer swings gradually to maximum compression pressure, then comes to rest, permitting close reading. Air pressure in gage may then be released by depressing a push-button vent valve. This permits taking compression readings in quick succession. "Universal" adapter serves 54 types of Diesel engines. (Other adapters available for commonly-used Diesel engines.) Other features include: handling convenience because of flexible extension; union connections on both ends of flexible connection permit positioning gage for reading ease and simplify interchanging of adapter; all adapters are designed to hold replaceable pressure-trapping device cartridge.—*Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh 8, Pa.*

Please mention number 1130 when filling out card

Volt-ohm-milliammeter

New "Model 625-NA," said to be widest range tester of its type, has following features: 5.6" mirror scale; resistance ranges from a low 0-2000 ohms (12 at midscale) to high of 40 megohms; dual d-c. voltage ranges to 2500 and 5000 at 20,000/10,000 ohms volt respectively said to provide double the number of full-scale readings of average testers. A-c. volt ranges to



CURRENTLY
SORENSEN & COMPANY, INC.
Manufacturers of
VOLTAGE REGULATORS, NOBATRONS & ELECTRONIC APPARATUS

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SORENSEN
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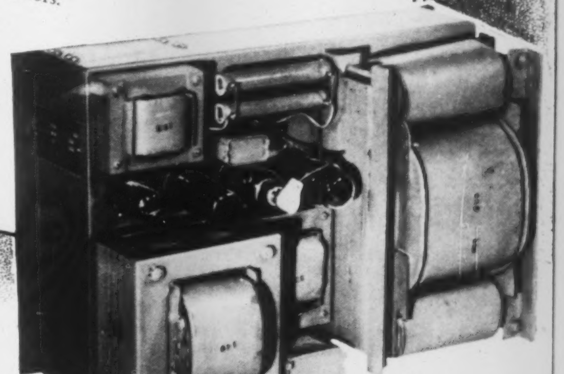
SORENSEN
S
& COMPANY

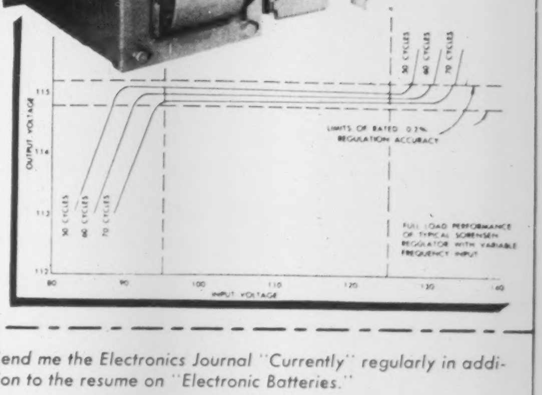
RUNAWAY VOLTAGES STOPPED AT 1/10 OF 1%

Rated performance of Model 1750-S *guarantees* delivery of output line voltages at a regulation accuracy of 0.2% under varying load. However, in *actual tests* of this unit voltage stabilization was held to within *0.1%* under full operating conditions. This conservative safety rating of 0.2% is typical of all Sorensen performance factors.

Input voltage range	95-125
Adjustable output between	110-120
Load range	200-2000 VA
Regulation accuracy	0.2%
Harmonic distortion	2% max.
Recovery time	6 cycles
Input frequency range	55-65 cycles



IT IS "A NATURAL" FOR CONTROLLING VOLTAGES IN LABORATORIES, ASSEMBLY LINE TESTING AND AS A COMPONENT OF YOUR ELECTRICAL UNIT.



Write for the latest in electronic developments

☐ Send me the Electronics Journal "Currently" regularly in addition to the resume on "Electronic Batteries."

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COMPANY________
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375 FAIRFIELD AVE. • STAMFORD, CONN.

THERMOWELLS by TRINITY

MADE of all machinable metals, capable of handling most corrosive materials. Manufactured to the ultimate in exacting tolerances. Individually tested to **assure** satisfactory performance.

Inquiries Are Invited

TRINITY EQUIPMENT CORP.

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Instrument Technician

For complete servicing of indicating and recording instruments and multimeters and should be familiar with the use of power tools. Single. Give experience and education in first reply. Job located in New Mexico. Box 137, Instrument Publishing Co., 1117 Wolfendale Street, Pittsburgh 12, Pa.

An Unusual Opportunity for a Sales Minded Engineer

One of our clients, specializing in the sale of control instruments to the process industry, has an excellent opening for a high type, technically trained, graduate engineer.

He should be from 30 to 35 years old, have had experience in the oil or chemical processing field, and must possess a real desire to get into sales work.

This is not just another job but a real opportunity to make a life-long connection with a long established, highly rated Philadelphia organization. Starting salary commensurate with experience and ability. Good opportunity to progress.

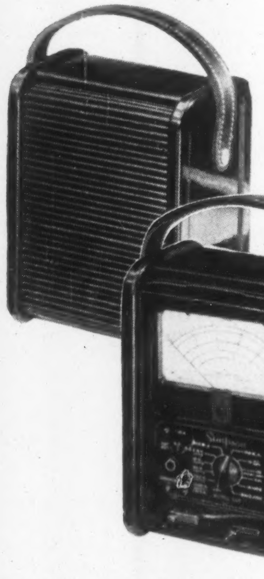
Apply by letter only, writing in full detail. Box 138, Instrument Publishing Co., 1117 Wolfendale Street, Pittsburgh 12, Pa.

5000 at 10,000 ohms/volt permit checking many audio and high-impedance a-c. circuits where a VTVM usually is required. Low voltage ranges permit direct measurement of many bias and output voltages. D-c. ranges from 0-50 microamperes to 0-10 amperes. Decibels: −30 to +69 db. Insulated 2½″ × 5½″ × 6″ molded case has removable strap handle. Leads and instructions furnished. Weight: approx. 3 lbs.—*The Triplett Electrical Instrument Co., Bluffton, Ohio.*

Please mention number 1131 when filling out card

Roll-top Carrying-case Electrical Instruments

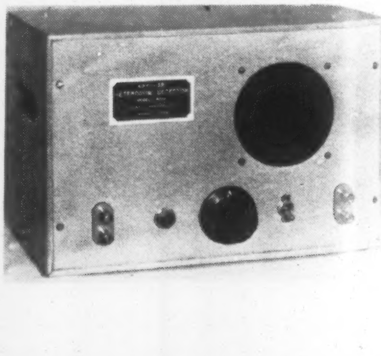
New "Roll Top Safety Case" combines case and instruments. Instrument itself is permanently fastened into case which is of molded Bakelite, large enough to provide a compartment for leads beneath instrument. Front is covered by "Roll Top" panel, a sliding cover of narrow Bakelite segments on a backing of cloth. Leather carrying handle completes assembly.—*Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.*



Please mention number 1132 when filling out card

Heterodyne Detector

New "Kay-Lab" heterodyne detector measures signals of 100 microvolts, is usable from 500 cps. to 50 Mc. Wide frequency range is possible because no r-f. amplification is taken. Instrument is used to compare an unknown frequency with that of a signal generator, permitting comparison of fundamental frequencies over entire range and there-

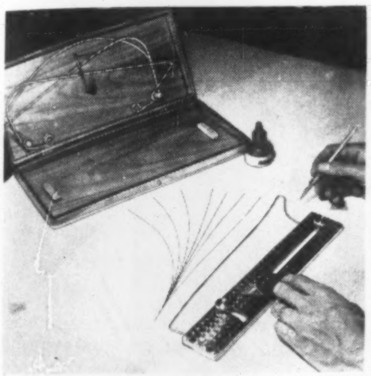


by eliminating, it is said, ambiguity which often exists in heterodyne frequency meters operating from harmonics of a narrow-band built-in oscillator. Sensitivity is sufficient to pick up local broadcast stations as frequency standards for checking laboratory oscillators. Audio frequencies may be measured as well as radio frequencies, because human ear detects zero-beat condition even in presence of continuous audio tones. In addition to measuring frequency, heterodyne detector will also demodulate an AM signal without use of a second oscillator. Circuit consists of a pentagrid converter and a high-gain audio amplifier with loudspeaker.—*Kalbfell Laboratories, Inc., 1076 Morena Blvd., San Diego 10, Calif.*

Please mention number 1133 when filling out card

Draftsman's Curve-drawing Instrument

New "Infinarc" for drawing curves is said to be based on an entirely new principle. Desired curve is obtained with specially-tempered wire forms whose shape is altered by moving either or both of two adjustment screws along slots. "Infinarc" is available with a 12″ base and four preformed wire curves with which it is possible to produce almost any shape desired, including reverse curves. Wires are quickly interchanged by snapping loops over ends of adjustment screws. Instrument is made of stainless steel; comes in clear-lacquered wood case.—*Cook Specialty Co., Green Lane, Pa.*



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Audio-frequency Meter

New "Model 300 Audio Frequency Meter" permits making direct measurements of unknown audio-frequencies up to 30,000 cps. Ranges: 0 to 100; 300; 1,000; 3,000; 10,000; and 30,000. Circuit consists of an input voltage

B&W
FREQUENCY METER

18

GOOD REASONS FOR BUYING

Permanent Magnets

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- ALNICO VI
- ALNICO XII
- COMOL (Remalloy)

Every one of these permanent magnet materials is different. And every one of them is "*best*" in some specific application—because it is the one material which will meet all performance requirements at the least material and fabrication cost. These are *17* good reasons for dealing with Thomas & Skinner—because Thomas & Skinner supplies magnets in *all* these materials—cast, formed or sintered.

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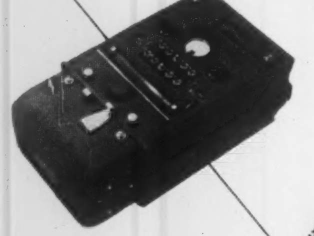

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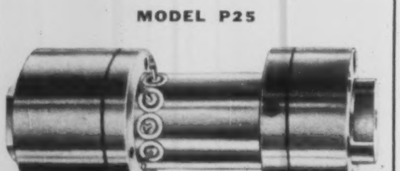
STATHAM PRESSURE TRANSMITTER

MODEL P25



An accurate and rugged instrument providing remote electrical indication or recording of differential pressures. For use at line pressures to 500 psi. Available in differential ranges between 0-1 psi and 0-500 psi. Recommended for use with conducting, inflammable or mildly corrosive liquids.

Minute deflection and light weight of the sensitive element makes it responsive to extremely rapid pressure variations.

Power requirements are a few dry cells, or any stable power supply furnishing a few volts at a small fraction of ampere, A.C. or D.C. A panel type microammeter, recording galvanometer or potentiometer, or cathode ray oscilloscope may be used without amplification. Carrier systems may also be used.

Size: 1¾ Dia. x 4¼
Wt.: 24 Oz.
Range: 0-1 psi to 0-500 psi
Pressure connection: 1/8" internal pipe thread

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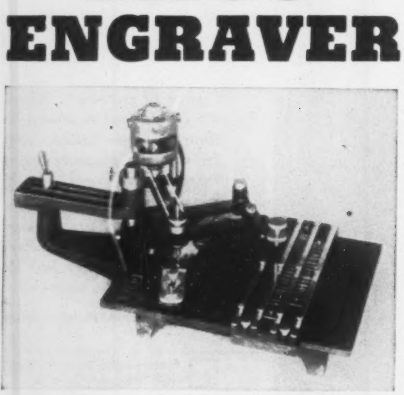

For lettering panels of steel, aluminum, brass, or bakelite, or for making finished apparatus.

Attachments adapt it to small or large work on flat or curved surfaces.

Excellent engraving can be produced by an inexperienced operator.

Widely used for production as well as occasional engraving.

Catalogue on request

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gain amplifier followed by two limiting amplifiers. Second of these feeds an *RC* integrating circuit and full-wave rectifier, d-c. voltage output of which increases linearly with frequency. Unit has an integral power supply. A high-impedance input circuit plus low-input operating voltage permits operation from 'phone jack of a standard receiver for measuring audible beat between two r-f. carriers. Sensitivity is a minimum of 0.5 volts input. Frequency meter will operate on any wave-form with peak ratios of less than 8 to 1. Instrument operates on 110-volt 60-cycle a.c., consumes 50 va. Dimensions 13¾" × 7¼" × 9½"; weight 10½ lbs. —*Barker & Williamson, Inc., 237 Fairfield Avenue, Upper Darby, Pa.*

Please mention number 1135 when filling out card

Rotary-actuation Micro Switches

New "LMR5" for industrial limit switch applications combines a new type of switch housing with a new design of rotary actuator, to provide protection, actuating means, conduit connection and convenient mounting for basic switching element within housing. Arm is adjustable through 360° with a total travel of 90° in either direction. Conduit fitting has standard ½"-14 NPSM internal threads. Symmetrical mounting holes make possible four mounting positions on either face. Operating force, 4 to 12 oz.; release force, 2 oz. min.; pretravel, 10° to 30°; movement differential, 1° max., or 0.027" max. at roller; overtravel, 55° min.—*Micro Switch, Freeport, Illinois.*

MICRO SWITCH
FREEPORT ILLINOIS U.S.A.

Please mention number 1136 when filling out card

Multipliers for Microphone Range Extension

New series of non-frequency discriminating multipliers extend upper range of sound pressures that may be directly measured with maker's "Models GA-1002 and GA-1004 Sound Pressure Measurement Systems." Photograph shows standard ×10 multipliers available for "M-101" or "M-106" micro-

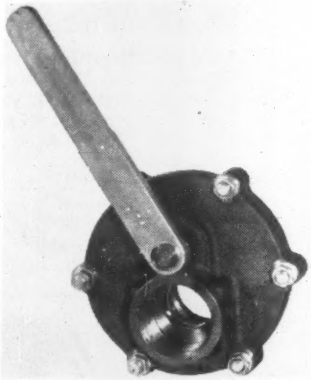
6
M-109 SOCKET
M-101-X10 MULTIPLIER
M-101 MICROPHONE
M-101-X10 MULTIPLIERS

phones. Left-hand view shows a multiplier inserted in place between microphone and microphone socket. When multiplier is inserted between preamplifier socket and standard microphone, "Model M-101-×10" unit extends upper limit of sound pressure measurements for "GA-1002" equipment from 20,000 dynes/cm.^{2} (160-db level) to 200,000 dynes/cm.^{2} (180-db level) over frequency range 20 to 20,000 cycles. "Model M-106-×10" unit extends upper limit of "GA-1004" equipment to the same levels except that increase results over frequency range up to 100,000 cycles.—*Massa Laboratories, Inc., 3868 Carnegie Ave., Cleveland 15, Ohio.*

Please mention number 1137 when filling out card

Shut-off Valve

New shut-off valve features quick-opening operation, leak-proof characteristics and heavy-duty all-steel construction. Designed for butane and similar service, it is available also for water or corrosive service with a heavy

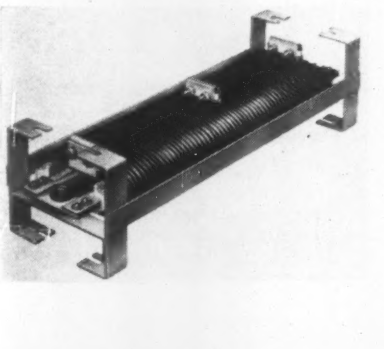


cast bronze body. Valve illustrated fits 2" pipe size with a straight-through 1¹¹⁄₁₆" opening. Only 18 lbs. force required at end of handle to operate at 200 lbs./in.^{2}. "Shear-Seal" principle provides a self-aligning metal-to-metal seal that compensates for wear. Foreign materials are wiped away. Valve requires no lubrication or packing adjustment throughout its life.—*Saval Co., 1915 East 51st St., Los Angeles 11, Calif.*

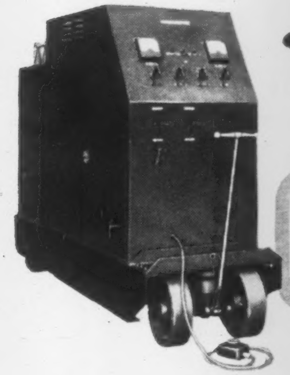
Please mention number 1138 when filling out card

High-current Resistors

New "Edgeohm" high-current resistors are applicable for use as starting, dynamic braking, field discharge and plugging resistors on d-c. or a-c. motor controllers and for other intermittent-duty high-current applications; also for continuous-duty uses in load banks; battery charging, welding and plating rheostats, etc. They consist of a con-



Portable, High-capacity, High-voltage Testing Units



G-E portable high-voltage test set, 60 cycles, 300 kva, 30,000/60,000 volts, 2300-volt supply, with 50 per cent exciting-current transformer and electrically operated oil circuit breaker.

For testing cables, generators, large motors, transformers, and other high-voltage equipment, a *portable* high-capacity testing unit provides convenience, speed, and accuracy.

Write General Electric for a proposition. Information on these points should be included: test and supply voltages, kva, material to be tested, type of test, and doorway clearances. A suitable unit utilizing standard components will be quoted. *Apparatus Dept., General Electric, Schenectady 5, N. Y.*

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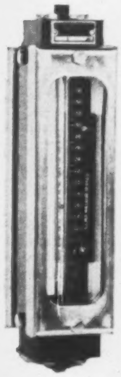

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We do not accept rubber-stamp calibration curves, even when we use our standard metering tubes and floats. Each rotameter is individually calibrated for the conditions under which it will operate, and a hand-cut flow scale is engraved for it in our factory. Its high accuracy is the result of our deliberate, effortful program to improve rotameter accuracy. If you want accurate flow rate measurement, try the Full-view rotameter with Safety Shielding. For further information, write for Folder No. 20 to Brooks Rotameter Company, Box A-51147, Lansdale, Pa.

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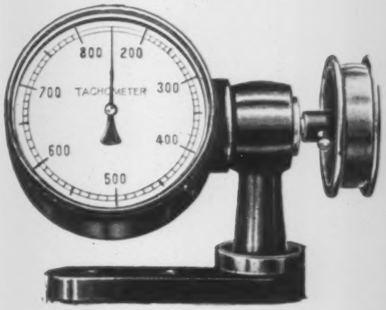

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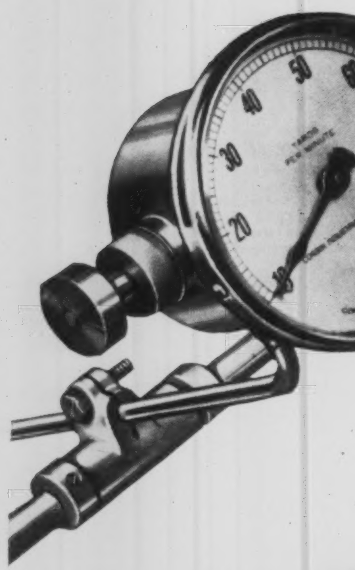

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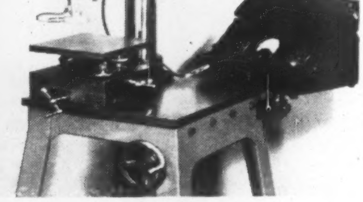
tinuous piece of non-corrosive alloy ribbon wound on edge in the form of oval coils, having clamp type terminals secured to ends of coils. Oval coil permits flexibility in both location and number of taps. Standard units are rated at 2,200 watts for continuous duty, available with resistances from 0.3[illegible] to 4.[illegible] ohms and with continuous-current capacities from 21 to 79 amperes. A single "Edgeohm" resistor with a duty cycle of 5 seconds on out of each 8[illegible] seconds is rated at 17,000 watts, based on 375°C temperature rise.

Multiple units up to four can be furnished in a single open frame. Frames of same length and width may be stacked in banks. Secondary insulation is provided between bracket of frame and each resistor unit. Additional clamp terminals for multi-tapped connections may also be supplied.—*Ward Leonard Electric Co., Mount Vernon, N. Y.*

Please mention number 1139 when filling out card

Rotary Accessory for Surface Measurements

New "Rotary Piloting Fixture" for circular tracing with "Profilometer" provides for taking microinch surface roughness measurements around in-

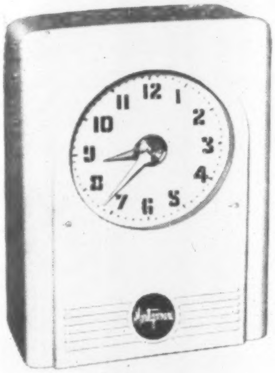


ternal and external surfaces of rotation such as cylinders, spheres and toroids, and on circular flat surfaces such as rings, grooves and bosses. It permits tracing on surfaces from 1/16" to 10" diameter (ID or OD) and accommodates work to 10" height. Workpiece is held stationary while tracing point is moved over surface to be measured. Spindle is motor-driven and, to provide same linear tracing speed for all diameters of trace from 1/16" to 10", a variable-speed drive of extra-wide range is employed. Length of arc traced is controlled by limit switches operated by two adjustable collars on upper end of spindle, and spindle reverses automatically on reaching limits set. Collars can be removed to permit continuous spindle rotation when desired.—*Physicists Research Co., 321 S. Main St., Ann Arbor, Mich.*

Please mention number 1140 when filling out card

Two-circuit Program Clock

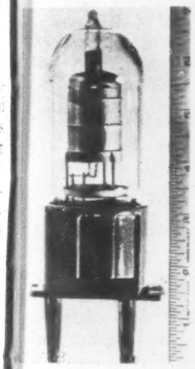
New "L Series" two-circuit synchronous program clock for school and industrial signalling incorporates two program disks, one mounted behind the other, whereby two signalling circuits ring on independent schedules. This is of particular value where staggered shifts pose a problem. Each circuit is provided with program cut-out and manual ringing switches for extra-schedule signalling. Manual ringing does not interfere with automatic schedule. Both circuits are silenced during regularly-scheduled "off" periods by a single automatic calendar switch. Time-movement and program mechanism are permanently synchronized and both are set by turning hands on dial. Program signals are set by hand-inserted spring clips in numbered slots on program disks. Metal cabinet is 11" high × 8" wide × 4" deep. Clocks are available with program disks for either 12-hour, 2½ minute interval or 24-hour, 5-minute interval cycles. — *Montgomery Mfg. Co., 549 West Washington Blvd., Chicago 6, Ill.*



Please mention number 1141 when filling out card

High-voltage High-altitude Vacuum Tube

New vacuum-tube design is for use on high voltages at altitudes up to 60,000 feet. Base of tube is of glass, tapered and ground to fit socket like a glass bottle stopper. This construction is said to exclude all air which, at high altitude, causes flash-over between terminals. Tube socket taper is counterpart of tube. Taper angle is chosen large enough to avoid trapping air when tube is plugged into socket. Design keeps air exit open until bottom of tube reaches bottom of socket. Socket is of Mycalex, a bonded glass-mica composition which will not carbonize in event of an electrical breakdown, is impervious to moisture, retains its dimensions under extreme temperature conditions and can be molded to close tolerances. Original tube designed for Air Forces is a high-vacuum, half-wave rectifier rated at 14,000 volts peak inverse. It can deliver an average plate current of 125 ma. and a peak plate current of 750 ma. Although rated 14,000 volts peak, this tube-socket combination will handle voltages as high as 35,000 volts peak. New design is applicable to all types of high-voltage vacuum tubes



VACUUM THERMOCOUPLES
FOR MEASUREMENT OF CURRENT AND TEMPERATURE

HEATER TYPE

This type provides a means of accurately measuring alternating currents of any frequency with a sensitive direct-current instrument. Among the many uses for this type of thermocouple are the following:

1. Measurement of small alternating currents of any frequency.
2. Measurement of larger currents of any frequency when only a small voltage drop is permissible in the measuring instrument.
3. Measurement of voltages of any frequency when only a small current is permissible in the measuring instrument.
4. Measurement of both current and voltage when frequency is higher than can be measured by other types of instruments.

RADIATION TYPE

These thermocouples are intended for use with a millivoltmeter in indicating, recording, or controlling temperature. They are particularly useful for measurement of solar radiation, for high-temperature measurements where conventional thermocouples deteriorate, and for such applications as measuring the temperature of rapidly moving objects on conveyors where, because of surface conditions, etc., it is not convenient to attach conventional thermocouples. For further information contact your nearest G-E office. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

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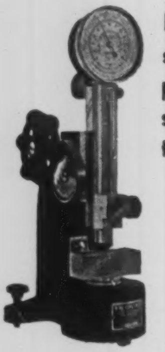

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Type 518

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Leakage resistance greater than one million megohms. These meters may be used to measure

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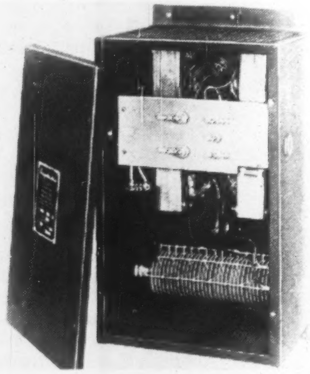
which may be subjected to similar high-altitude conditions. When used in areas which are strongly radioactive tubes of this type will not break down externally under ionizing radiation.—*Amperex Electronic Corp., 25 Washington St., Brooklyn, N. Y.*

Please mention number 1142 when filling out card

Constant-voltage Rectifier

New selenium rectifier maintains constant voltage regardless of changing amounts of current drawn from it. Its prototype was designed to solve problem in electrical systems of pipe organs: to handle large gangs of low-voltage d-c. magnets in varying loads from zero to 20 amperes with no appreciable voltage variation. Reactor type d-c. voltage control will maintain or increase starting voltage until full current has been drawn from rectifier whereas, in ordinary rectifiers, voltage drops as current is increased. Announcement states that "whether one magnet or a thousand of them are connected, the voltage is the same." Rectifier itself is a full-wave bridge type suitable for any a-c. frequency and a line voltage of 115 to 230. Pulsating d.c. is filtered about 25%, but a smoother current can be supplied if necessary. New unit occupies about a cubic foot of space, is believed to have many potential uses in industrial field.—*La Marche Mfg. Co., 6525 Olmsted Ave., Chicago 31, Ill.*



Please mention number 1143 when filling out card

Remote Digital Indicator

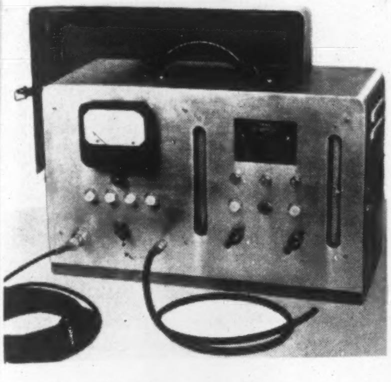
New "Silent Rotary Indicator" is electrically operated, displays numbers from 1 to 10 printed on a rotating cylinder. Operation is noiseless. Applications include electrically-operated stock quotation boards, air traffic con-

trol systems, totalizators, clocks, annunciators, etc. Single moving part turns on a porous bronze bearing, is operated magnetically without mechanical attachment. Automatic reset is by spring return. Speed limit is 15 steps per second or 0.7 second for complete step-by-step operation from 1 to 10. Indicator operates on 48 volt d.c., 0.043 amp. Each character is ¼″ wide and ⅝″ high. Unit is 1¼″ square and 3″ long.—*Stevens-Arnold, Inc., 22 Elkins St., South Boston 27, Mass.*

Please mention number 1144 when filling out card

Toxic-gas Analyzer

New "Micro-Gas Analyzer" utilizes electrical conductance of solutions. Any gas which will ionize in water, with or without heat, may be analyzed in toxic range. Included are all chlorinated hydrocarbons, CS_2, H_2S and SO_2. In operation, gas is drawn into analyzer by a small pump, passes through a "Flowrater" and enters a combustion furnace where it is decomposed. From furnace, gas passes into cell through which solution is being pumped. As decomposed gas dissolves in water, electrical conductance changes. This permits electrical measurement in PPM of gas being analyzed. By varying solution flow and air flow, determinations may be changed from one gas to another. (A chart included with instrument gives flow-rates.) Analyzer weighs approx. 33 lbs., operates from 110-volt 60-cycle supply.—*Davis Emergency Equipment Co., Inc., 45 Halleck Street, New York 4, New Jersey.*



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Color Temperature Conversion Filter

New "Chance OB9" glass for color temperature conversion filters is said to be of particular interest to physicists in photometric laboratories and similar institutions. Light from source under test is usually matched against light from a standard electric lamp of known characteristics. Such lamps operating at high color temperatures are likely to be unstable and it is inadvisable to use vacuum lamps above 2400°K. while a gas-filled lamp burns at maximum satisfactory limit at 2848°K. Under these conditions, useful life of such lamps is short. New glass enables lamps run at their normal rating to be used as high-color-temperature sources. For example a filter of Chance

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The use of fractional horsepower motors with integral speed reducers in your instruments will enable you to obtain output speeds exactly as you want them. Power application will be close to the driven unit without complicated and expensive gearing. For these reasons, many designers are now building machines with a number of small motors instead of one large one.

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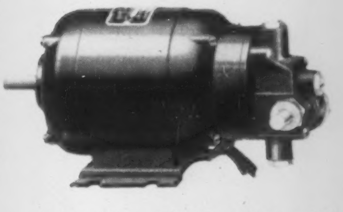

Bodine Type NSY-RR motor with integral double, worm-gear speed reduction.

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OB9, 1.6 mm. thick, used in conjunction with a lamp at 2250°K., will form a source which matches the color of a Planckian radiator at 2880°K. Announcement gives tables of characteristics (too long to be reprinted here) also a discussion of suitability of any particular filter in terms of difference between Y coefficient of color of lamp-and-filter combination and Y coefficient of the Planckian radiator having the same X coefficient. This difference is the Δy of the filter. A Δy of 0.001, just observable by an experienced observer, may give rise to a difference of about 12°K. in estimation of color temperature by two observers. For an ideal filter, difference between reciprocal of color temperature of illuminant and combination should be constant; performance of an ideal filter can therefore be expressed in mireds conversion per millimeter thickness. "OB9" satisfies these conditions closely and gives a conversion of 60 mired per mm. Tables of characteristics show that as source color temperature increases value of Δy decreases and filter approaches more closely to ideal. Announcement states that new glass "appears to be about twice as good as other commercially available glass."—*The Ednal Co., Inc., 95 Madison Ave, New York City.*

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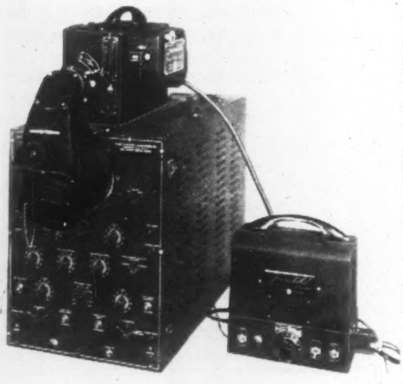
Oscilloscope Camera

New "Oscillo-Record Camera" is said to be the first camera especially designed for general-purpose use in recording oscilloscope traces. It is a



35-mm. camera equipped for mounting atop standard laboratory oscilloscopes. It makes still or continuously-moving film records; photographs high-speed phenomena as well as very-low-speed phenomena (too low for visual continuity); is suited for quantitative studies of oscilloscope traces, for record purposes, and for tests using new multiple-beam tubes. By using sweep circuit of 'scope in conjunction with variable-speed drive, speed of trace photographed is limited only by 'scope writing speed. By adjusting film speed, camera records each successive sweep across film without use of a shutter. If desired, moving film can be used as the sweep, giving a continuous recording along film. Film rate is continuously adjustable from 1" per minute to 3,600" per minute (5 ft. per second). Provision is made for single exposures by a shutter with speeds of one second to 1/400th second. Its frame size can be adjusted to to double 35-mm. size. It is possible to have camera running, for example, at 60" per minute and shift it immediately to 60" per second. "Oscillo-Record Camera" takes standard 100-ft. rolls of 35-mm. film, or film in standard 400-ft. or 1,000-ft. magazines. With 100-ft. rolls, camera operates from 20 seconds at maximum speed, to 20 hours at minimum; with 1,000-ft. magazine, from 3⅓ minutes to 200 hours. A footage indicator is provided. Mounting: camera is easily set up on top of 'scope (out of way of controls) and mounting arrangement automatically insures correct focus. Provision is also made for tripod mounting. Operator may view readings of 'scope while they are being photographed. An illuminated card, supplied with camera, permits such data to become part of film record: no danger of loss or mix-up. Specifications for camera were set up by such oscilloscope manufacturers as Dumont, RCA and Bell Labs, and by users such as NBC and CBS.—*Fairchild Camera and Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y.*

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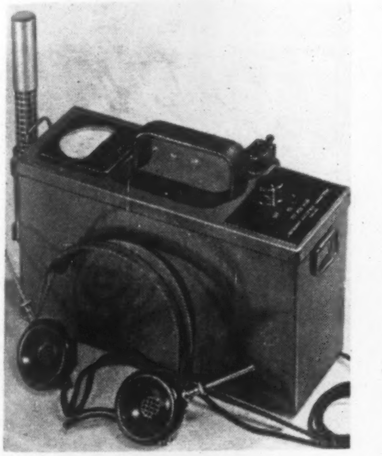
Portable Radioactivity Meter

New "Model 2610" portable beta-gamma count rate meter is intended for qualitative and semi-quantitative measurement of x, gamma, and beta radiation. Its small size (11" × 4" × 6") and weight (9½ lbs.) make it convenient for finding radon needles and in geological surveying for radioactive ores. It has three ranges: 0.2, 2, and 20 milli-roentgens per hour full scale. Instrument range below cosmic ray background and above health tolerance level. High sensitivity makes possible many applications to radiation measurement in diagnostic medical research. Count rate circuit uses two hearing-aid-type tubes and is completely battery-operated. In addition to visual indication of amount of radiation present, earphones are provided for oral indication. Battery life, based on an average operating period of four hours per day, is about 350 hours. Detachable chrome-plated probe is mounted in a clip on front of instrument. An adjustable shield can be set to prevent detection of beta particles, so that user can distinguish between beta and other radiation.—*Instrument Development Labs., 223-233 W. Erie St., Chicago 10, Ill.*



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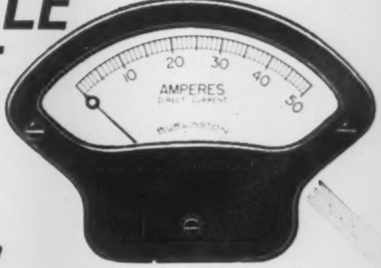

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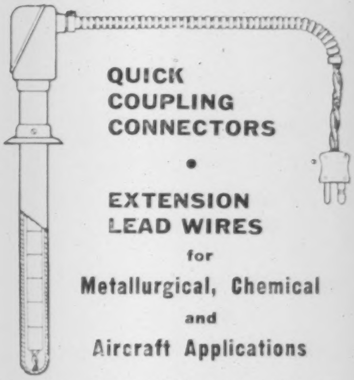

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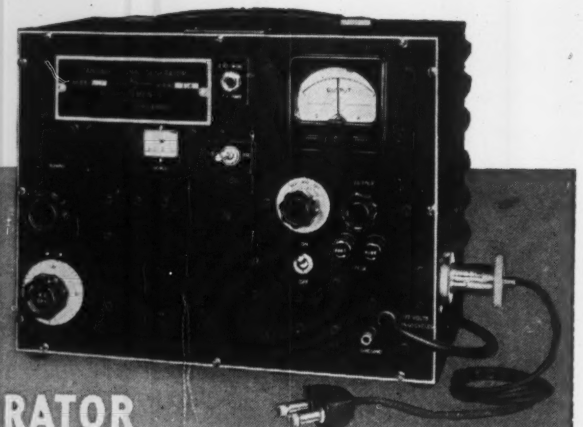

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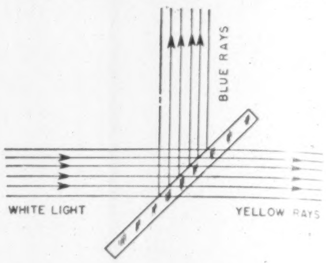

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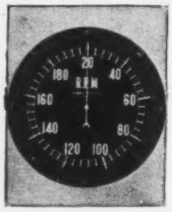

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JOURNAL of the Instrument Society of America

Editor, R. R. PROCTOR, 2213 Ridge Ave., Evanston, Ill.
I.S.A. National Office, 1117 Wolfendale St., Pittsburgh 12, Penna.

Vol. 2 NOVEMBER 1947 No. 11

Editorial

DEMAND FOR INSTRUMENT MEN EXCEEDS SUPPLY

During the Second Annual Conference and Exhibit in Chicago in September, the annual meeting of the Society was held on Monday afternoon, September 8th, and those present were privileged indeed to hear several fine reports, including the one by Cy Goldcamp, Chairman of the Employment Committee.* Whether he realized it or not, Mr. Goldcamp did a fine bit of editorializing in his report. Due to the heat, hubbub and other factors, many of those present (including the delegates whose duty it was to report the information back to their various Sections) may have missed the point summarized in the heading of this editorial, and we believe that it should be brought pointedly to the attention of every member of the I.S.A., to every reader of this publication, and to everyone else interested in instrumentation — from top management on down.

Quoting freely from Cy Goldcamp's report, the interest in, and the need for, instrumentation in industry is growing rapidly, as may be attested by the large number of manufacturers represented at the recent Second Annual Instrument Conference and Exhibit. The need for more and more instrument men is growing with the increased interest in instrumentation, and even now, the demand for instrument men exceeds the supply as may be illustrated by the following extracts from recent letters received by the Employment Committee from concerns in need of men:

"We hope the announcement in your publication (the JOURNAL) will attract some well qualified people who may be seeking employment opportunities with an outstanding and recognized research laboratory . . . experienced instrument men are extremely hard to locate."

Another one writes, "We are enlarging our instrument department and badly need instrument mechanics."

Still another says, "This instrument department represents a new development in our plant, and a worthwhile opportunity for men with the proper qualifications if they may be obtained."

An instrument manufacturer says, "In reply to your communication, we well realize the scarcity of good instrument salesmen as we have been trying for two months to fill our two openings."

This scarcity of available instrument men as indicated by the above extracts is further borne out by the following rather startling fact, also worked out from the records of the Employment Committee:

The average number of applications received per open position announced in the JOURNAL during October and November, 1946, was 8.03. The average number of applications received per open position announced during June and July, 1947, was 2.41. *This represents a decrease of 70% in men available over a 7-month period.* (This decrease was not due to lack of open positions entirely, since the decrease in open positions announced in that period was only 12.5%.)

This scarcity of instrument men is being accompanied by an increase in rate of pay for the instrument mechanic. While our knowledge of the rate situation is not extensive and is dependent upon the rates offered by manufacturers having open positions (plus reports from committee members and answers to some direct letters), there has been sufficient data accumulated in the files of the Employment Committee to indicate that the average rate for the instrument mechanic has increased an even 25% from October, 1946, to September, 1947.

In our opinion this definitely indicates a recognition on the part of industry of the importance of the instrument mechanic. The salary rate for the instrument engineer has also advanced, but it is not possible to determine just how much percentagewise. However, the top salary on record for October, 1946, was $7500 per year as against the top salary for August, 1947, of $10,000.

As a further illustration of the awakening of industry to the need for instrumentation and qualified instrument men, Mr. Goldcamp, in his report, quoted the following extracts from two letters recently received by his committee:

"In a recent issue of the JOURNAL of the I.S.A., your company announced an opening similar to our announcement of an opening in the same issue. We seem to be unable to attract qualified men for the rate we are now offering, and would appreciate hearing from you as to the rate you offer and any other inducements for employment which you feel free to supply us."

And this one—"Please be advised that the opening listed at X Company is open again. The two men hired last month (through the I.S.A.) left us to work for Y Company of this city with a substantial increase!"

Mr. Goldcamp's closing remark was "It is our opinion that the day of the instrument man is here and it behooves all of us as a Society to do what we can to further the efforts of the Employment Committee in securing more satisfactory instrument men for the employer."

To which we would like to add our amen and the parting remark that the day of the instrument man is here, period. —RRP

Editor's Notes

1. THE NEEDLE POINTS TO—

Chicago, New Jersey, Niagara Frontier, Oak Ridge and Philadelphia for all-around good Section News Reports.

For the benefit of Secretaries and/or Correspondents of some of the newer Sections who have asked us how they should write up their news reports, we cite the above as typical examples. We would like such reports to be typewritten if possible, double-spaced, and in duplicate. Whether these conditions can be met or not, we would like to receive SOMETHING from each Section every month anyway—by the 15th of the month if possible, and not later than the 20th at the very outside.

—R. R. Proctor

General News

JET PROPULSION

The following is a brief account of the talk presented before the Instrument Society of America at the Annual Banquet in Chicago on September 10, 1947, by Dr. John T. Rettaliata, head of the Mechanical Engineering Department at Illinois Institute of Technology in Chicago.

After describing the developments and advances in jet propulsion since the idea originated some 2000 years ago, Dr. Rettaliata forecast an early end for the high-powered aviation piston engine, both for military and commercial use. In his address, Dr. Rettaliata, predicted that the gas turbine will be well entrenched within five years in the high-speed large commercial transport field, and within ten years its supplanting of piston engines for this use should be essentially complete.

Already the gas turbine-jet propulsion combination (turbo-jet) has replaced the piston engine-propeller arrangement in the latest high speed subsonic military fighter planes, according to Dr. Rettaliata, and the most recent bombers are also employing engines of the turbo-jet type.

(The speed of sound at sea level is 760 miles per hour; at 40,000 feet altitude it is 660 miles per hour. A speed below that of sound is referred to as subsonic, and above as supersonic.)

While its use will be restricted, the propeller will not disappear with the piston engine, he said. Gas turbines driving propellers (turbo-prop units) through reduction gears are the best type of aircraft power plant for moderate subsonic speeds.

As flight speed is reduced, the propulsion efficiency of jet engines decreases; whereas propeller efficiency is maximum at moderate speeds and falls off at high speeds, Dr. Retalliata explained. For speeds up to about 550 miles per hour, propellers in their present state will probably have predominant application. Even with further development, however, they will not be used on supersonic planes.

In supersonic speed ranges, three types of power plants for propulsion of aircraft are applicable:

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*NOTE: To those who heard and appreciated this report when it was presented, it will be apparent that we have quoted freely from its facts, figures and expressions of opinion. This note, therefore, is an apology to Mr. Goldcamp and his committee for the very evident plagiarism, and at the same time an expression of appreciation to Cy for presenting us with a copy of his report to be used in any way we saw fit.—RRP

1. Turbo-ram-jet engines—where additional fuel is burned in the tail pipe of a turbo-jet to increase the velocity of exhaust gas and hence increase thrust;

2. Ram-jet engines—composed of a simple duct, the forward end of which consists of a diffuser to slow down the high velocity of incoming air and increase its pressure, with the air next passing through a heating chamber, and finally expanding through a rear-duct nozzle and being emitted at high velocity to produce a thrust;

3. Rocket engines — carrying their own self-contained fuel and oxygen and, consequently, independent of the earth's atmosphere.

At supersonic speeds an airplane with a ram-jet engine would have the longest range, but it would have to be launched by some other means since the ram-jet is not self-starting. The next longest range could be obtained with a turbo-ram-jet engine, which has an additional advantage of producing a static thrust for take-off. The rocket engine will have the shortest range, but will give the greatest thrust per unit weight. This latter feature, Dr. Rettaliata explained, is the reason present attempts to break the sonic barrier are being made with planes employing rocket propulsion.

In the personal plane field, Rr. Rettaliata predicted that the low-power piston engine with propeller can expect a long life. "Notwithstanding some predictions to the contrary," he said, "the personal plane will not be jet-propelled. Nor does it appear likely that gas turbines driving propellers will be used as power plants for personal planes in the forseeable future. The small sizes make fuel consumption prohibitive.

"A compound engine, consisting of a piston engine whose exhaust gas is supplied to a gas turbine and the power from both furnished to a propeller, has some attractive possibilities for the future. A power plant of this type will give the longest range at low flight speeds.

"It might be thought, therefore, that such an arrangement would perpetuate the use of the high-power piston engine and prevent its predicted replacement. But such is not the case," he said. "Based on the developmental difficulties experienced with such engines, their commercial application appears to be of doubtful fruition. And the prophecy of the ultimate superseding of high-power piston engines by gas turbines is believed valid."

Official News

TO ALL SECTION SECRETARIES

To your already much-changed list of Section Secretaries, Delegates and Correspondents (published originally last February), several more changes can be made:

ARUBA: New Secretary — M. R. Holly, c/o Lago Oil & Transport Co., Ltd., Aruba, Netherlands West Indies; New Correspondent—LeRoy L. McGrew, same address.

NEW JERSEY: New Secretary—Geo. R. Feeley, 22 Bailey Road, Maplewood, N. J.

NIAGARA FRONTIER: Secretary—Russell Milham, 601 Walbridge Bldg., Buffalo, N. Y.

NORTHERN INDIANA: Secretary and Delegate—C. P. Haynes, c/o Red River Oil Refinery, 935 177th Place, Hammond, Ind.

OAK RIDGE: New Secretary—J. O. Alexander, 101 Hoyt Lane, Oak Ridge, Tenn.

PHILADELPHIA: New Correspondent—C. B. Petty, c/o Energy Control Co., 3147 No. Broad St., Philadelphia, Pa.

PRESQUE ISLE: Secretary — Roger P. Marshall, 161 West Main St., North East, Pa.

SARNIA: Secretary—R. K. Chamberlain, 314 Maria St., Sarnia, Ontario, Canada.

TULSA: Secretary—C. R. Horton, 510 So. Lansing St., Tulsa, Okla.

TWIN CITIES: Delegate—R. Marchant, c/o Minnesota Mining & Mfg. Co., 900 Fauquier Ave., St. Paul 6, Minn.

Next month we will publish a complete new listing, based on the results of a questionnaire sent to all Sections recently. It will be as up-to-date as it is possible for us to make it, and will be kept correct by notices such as this (and under this heading) in subsequent issues.

NEW YORK SECTION TO SPONSOR JANUARY "REGIONAL" MEETING

Conference to Feature Papers on Electrical Control Elements of Industrial Instrumentation

The New York Section of the Instrument Society of America is arranging a two-day conference (to be considered a regional meeting of the I.S.A.) on January 30 and 31, 1948. A full program has been planned on the general subject of the utilization of electrical methods in industrial instrumentation. The conference is to be held on Friday and Saturday, preceding the meetings of the American Society of Heating and Ventilating Engineers.

The Friday sessions will be held in the Engineering Societies Building, New York City, and will be devoted to the application of electrical resistance devices with papers describing the properties and uses of certain resistance units that are sensitive to temperature, others to the applied voltage across them, or to the current they pass. Humidity sensitive units and light sensitive resistors will be discussed, in each case with the practical applications being stressed.

Other talks during the day will be devoted to resistance strain gages and their uses in showing stresses, pressures of various kinds, displacements, etc. Another subject is that of the utilization of electrical conductivity in the analysis and control of materials in process.

The application of resistance devices has been expanded of late to many new tasks, not only because of the wide variety of effects which can be called upon to systematically alter the value of special units, but also because the units can be tied into the system in so many ways. Controllers, relays, indicating and recording instruments, oscillographs, etc., are all operated directly from a resistance variation. The list of speakers, each an authority in some phase of this field, will be published later in these columns.

The Saturday (January 31) sessions will be held at Columbia University, starting with a session devoted to descriptions and application notes relative to electrical recorders of various types and makes. The afternoon session will be devoted to computing instruments, both these relating to the solution of mathematical problems by electrical networks and to the digital and other types of computers, with demonstrations and a tour through the Watson Computing Laboratories at Columbia.

Another feature of the Saturday sessions running simultaneously, is a short course on electrical instrument maintenance, checking the basic methods of repair. At these sessions, which are open to instrument technicians, well known instrument authorities will describe and demonstrate meter troubles and discuss the rules for their repair—showing what can be made on the job, and procedures needed.

Section News

ARUBA

The fifteenth meeting of the Aruba Section was called to order at 7:15 on October 7th. During the business meeting the following actions were taken:

Motion passed to adopt the I.S.A. National By-Laws and draft a set of regulations to administer these By-Laws locally.

Committee appointed to draft such regulations.

Nominating Committee conducted the annual election. Officers elected for the coming season (November '47 to October '48) are President, J. L. Lopez; Secretary, M. R. Holly; Treasurer, W. O. Weber.

Annual Banquet scheduled for November 15th at the Flamingo Room in Oranjestad.

Applications of two members and three associate members presented and approved. (Incidentally, one of these applications was received from a former member of the Aruba Instrument Department, Walt M. Sawyer, presently with Foster-Wheeler Corp., Whiting, Indiana.)

Recommended Practices Committee report, based on information secured at the Chicago Conference, read by Stan Chapman, chairman of the sub-committee on Pneumatic Control Circuit Pressure Tests.

Followed then the talk of the evening, which was a very comprehensive report on the Chicago Conference and Exhibit by President Art MacNutt. Art, who was vacationing in the United States at the time, covered the Conference as "Delegate at Large" for the Aruba Section. In attendance at all business and committee meetings also was our alternate delegate, Jim Faucett, who is still vacationing in Chicago and environs at this writing.

At the close of President MacNutt's talk the meeting was adjourned to the refreshment counter.

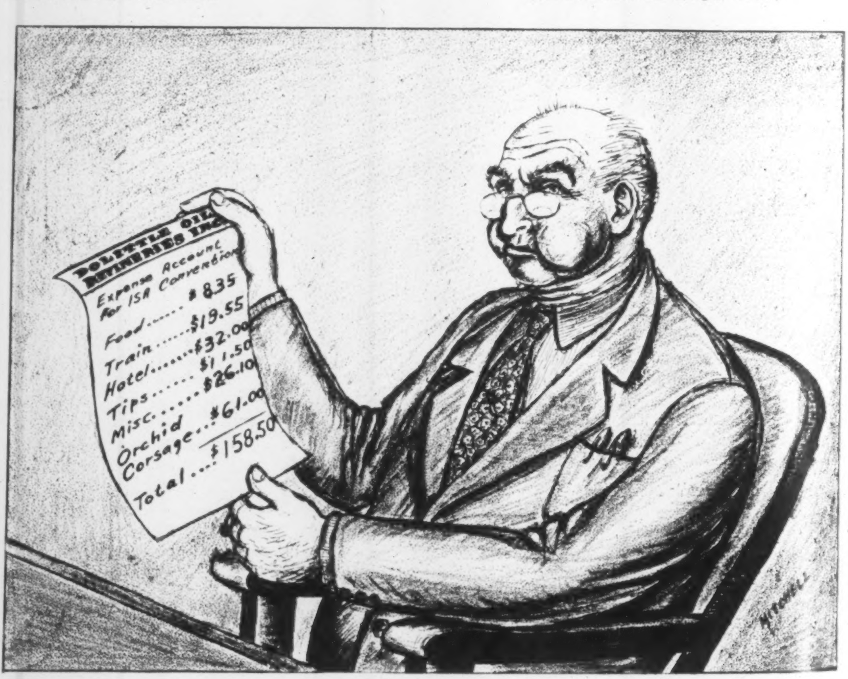
For further details on this and future meetings, reference may be made to the Aruba "I.S.A. Bulletin" which each Section Secretary now receives.

—J. L. LOPEZ, *Corr.*

CHICAGO AND NORTHERN INDIANA

Well over 100 members and guests of the Chicago and Northern Indiana Sections at-

(Continued on Page 1063)



"Colorful occasion, eh? Did all the men wear flowers at the Convention???"

Adaptation of the Automatic Spectrophotometer for Special Measurements*

By R. H. KIENLE and E. I. STEARNS

(A contribution of the Research Department, Calco Chemical Division, American Cyanamid Company)

THE automatic recording spectrophotometer such as that manufactured by the General Electric Company is a very useful instrument for a number of tests of chemical concentration measurements. As with any instrument manufactured for general use, special modifications are often useful to facilitate special measurements. Some of these modifications have heretofore been reported only in the patent literature, and it is the purpose of this paper to summarize some of these modifications that have been found particularly useful in chemical work.

Chemical Analysis of Reactions on Fibers

A certain class of dyes, known as chrome dyes, will dye wool from an acid dye-bath and produce a color, but the dye is much more durable, i.e. more resistant to light fading and more resistant to removal by sea water and other solvents, if the dye is metallized. This metallization in the top chrome dyeing process consists of adding sodium dichromate to the dyebath after the normal acid dyeing is complete and keeping near the boil for a half hour. It is poor practice to use too little dichromate as this produces insufficient chromation and consequent loss in durability and color variations in successive dye lots. Too much dichromate is a waste of material and may damage the wool by oxidation. It therefore is desirable to determine the correct amount of chrome, which can be done by measuring the extent of the metallization reaction in the wool.

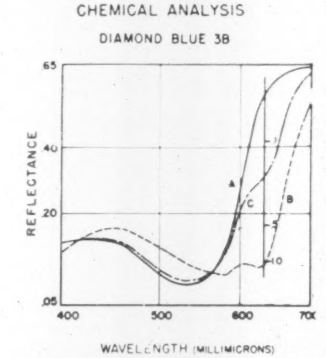


Fig. 1. Chemical Analysis on Wool, Diamond Blue 3B (C.I. 180). A—Acid dyed; B—Completely chrome dyed; C—Partially chrome dyed.

Fig. 1 shows the spectrophotometric curves of three five-gram skeins of wool yarn, the first acid dyed, the second completely chrome dyed and the third incompletely chrome dyed. Placing a logarithmic scale at 630 mu it is found that when curve B of the completely chromed wool falls on the scale at 1.04, curve A of the acid dyed wool intersects the scale at .04 and curve C of the incompletely chromed wool falls on the scale at .2. The percent chromation of the partially chromed wool is then

$$\frac{.2-.04}{1.04-.04} = \frac{.16}{1} \text{ or } 16\%$$

In order to arrive at the final answer, 16% chromation, with an elapsed time of less than fifteen minutes for measurement and computation, advantage was taken of two modifications. One is a rotating holder[1] shown in Fig. 2. The need for this holder is illustrated by Fig. 3 which shows the curves of the incompletely chromed skein run at several spots when the rotating holder was not used. The precision in percent chromation calculated from one spot is approximately 14—18%, expressed as 95% confidence limits. Since the effective area viewed by the spectrophotometer when the rotating holder is used is about 14 times as large as a single spot, the precision of the test with the rotating holder is 15.5—16.5%. It is true that equal precision could be obtained by measuring 14 spots and averaging the data, or by raveling and rewinding the yarn to make two or three samples, but these procedures are time-consuming. The rotating holder used for these tests has a diameter of four inches and is run at a speed of 150 rpm.

R. H. Kienle received his B.S. in Chemistry from Worcester Polytechnic Institute in 1916, his M.S. from Union College in 1927 and his Ph.D. from Rutgers University in 1938. He has served as chemist with General Electric (1916-17), Lieutenant, CWS (1917-1919), Research Chemist, Research Laboratory (1919-33), Research Chemist and Chief of the Physical Chemistry Division of Calco Chemical Company (1933-41), and Assistant Research Director, American Cyanamid Company (1941 to date).

E. I. Stearns received his B.S. in Chemical Engineering from Lafayette College in 1932, his M.S. from Rensselaer Polytechnic Institute in 1933, and his Ph.D. from Rutgers University in 1945. He has worked with Calco Chemical Division of American Cyanamid Company at Bound Brook, N. J., from 1933 to present date, and is at present Assistant Director of Physics Research.

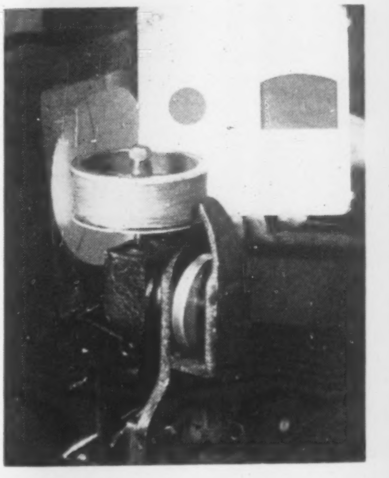


Fig. 2. Rotating Holder for Measuring Skeins. (During a measurement the removable part of the integrating sphere, shown held in the hand, is placed so as to complete the sphere, and a spring belt is placed on the large pulley for driving.)

A second modification is a cam[2] of such a design that the instrument plots log $(1\text{-}R)^2/R$ instead of R, where R = reflectance. This permits the use of a logarithmic scale to calculate the percent chromation nomographically. This could be done by calculation of the following equation where measured reflectance values have substituted in the proper places:

$$\frac{\frac{(1-0.300)^2}{0.300} - \frac{(1-0.565)^2}{0.565}}{\frac{(1-0.097)^2}{0.097} - \frac{(1-0.565)^2}{0.565}} = 16\%$$

This special cam, and a reference logarithmic scale, simplify this calculation. This cam is one in the cam assembly shown in Fig. 4 and may be shifted into place in five seconds.

Chemical Identification

In order to color various materials black it is often advantageous to use a mixture of different dyes in order to get the desired shade of black. Sometimes these dyes are mixed as dry powders, and in such cases it is frequently a problem to identify the individual components. When a little of this type mixture powder is placed on a spatula and blown off so as to fall on the surface of water in a beaker, the individual particles will settle downward, leaving behind streaks of practically pure dye solution. Fig. 5 shows the spectrophotometric curve of several of these dye specks of the same color. There are two curves shown. Curve A is the large range plot which covers 375 mu in 19

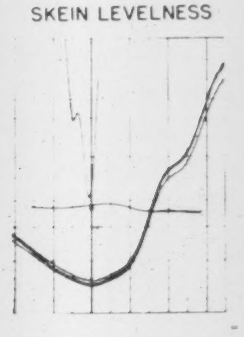


Fig. 3. Levelness of Incompletely Chromed Wool. (The triple curve represents three measurements on one skein of partially chromed Diamond Blue 3B, each measurement from a different spot. The skein was stationary during measurement—the rotating holder of Fig. 2 was not used.)

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*Presented at the Second Annual Conference of the Instrument Society of America, Stevens Hotel, Chicago, Ill., Sept. 8-12, 1947.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

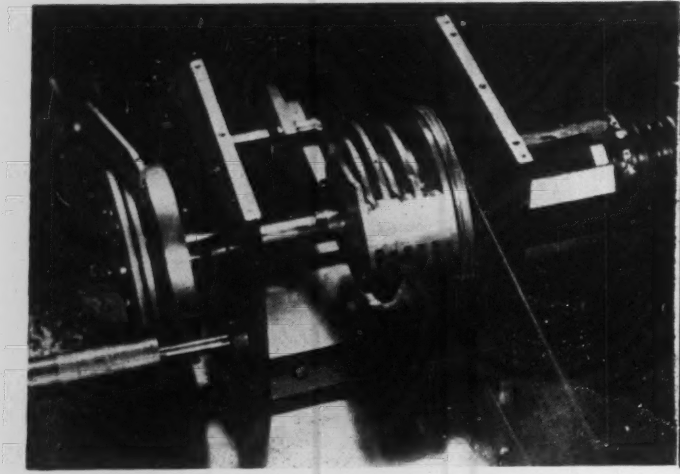

Fig. 4. Cam Assembly. (The cam is laterally movable when the shaft is rotated to a position in which the cam follower rests on the "shoulder" common to all cams.)

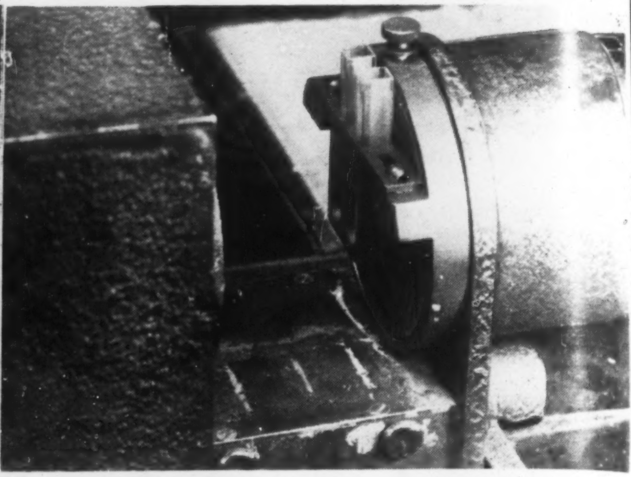

Fig. 7. Micro-transmission Cell. (0.0000006 grams of Methyl Violet B gives a curve with a transmittancy of 40% at 590 mu, adequate for identification.)

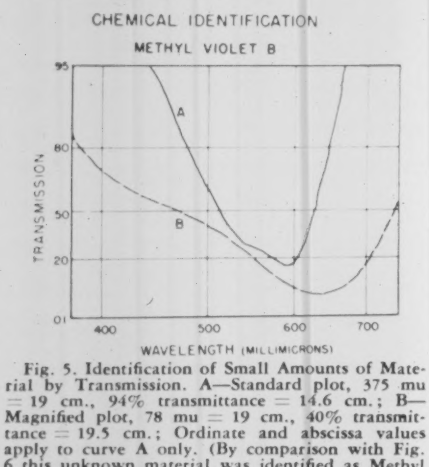

Fig. 5. Identification of Small Amounts of Material by Transmission. A—Standard plot, 375 mu = 19 cm., 94% transmittance = 14.6 cm.; B—Magnified plot, 78 mu = 19 cm., 40% transmittance = 19.5 cm.; Ordinate and abscissa values apply to curve A only. (By comparison with Fig. 6 this unknown material was identified as Methyl Violet B (C.I. 680).)

centimeters and a transmission range of 94% in approximately 16 centimeters. Curve B is a magnified plot which shows 1/5 of the transmission range and 1/5 of the wavelength range on the same size plotting paper ($8\frac{1}{2}'' \times 11''$ cm.) From the large range plot the curve shape index[3] is found to be 1-50-70-40.

A curve compendium index of all previously measured dyes in this solvent shows only three that might be considered—methyl, crystal and ethyl violets. The absorption maximum positions of these dyes are so close together (2 mm. on the regular plot) that it is best to use the magnified plot for final identification. The magnified plots for these three possible dyes are shown in Fig. 6. The agreement of the curve shapes indicates that the unknown dye is methyl violet.

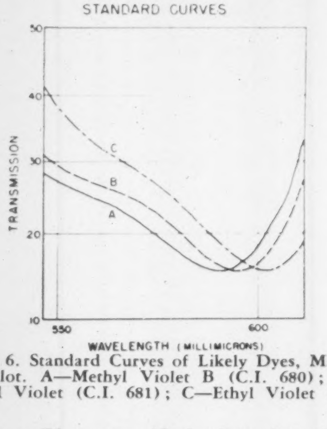

Fig. 6. Standard Curves of Likely Dyes, Magnified Plot. A—Methyl Violet B (C.I. 680); B—Crystal Violet (C.I. 681); C—Ethyl Violet (C.I. 682).

In order to arrive at this identification in a matter of fifteen minutes, advantage was taken of six modifications. A micro-transmission cell as shown in Fig. 7 was used. This cell has a minimum cross-sectional area of 0.25 sq. cm., and holds a total of 0.125 cc. The minimum weight of methyl violet required for an identification is 0.0000006 grams, or 0.6 microgram. It is placed in the instrument immediately adjacent to the decentered lenses.

The light beam is too large to pass through the sample and therefore an optical stop is placed at the exit slit as shown in Fig. 8. Optical stops are also available for reflectance measurements and are advantageously placed in the instrument near the face of the second monochromating prism.

A third modification in this series is a cam[4] of such a design that the instrument plots log log 1/T instead of T, where T = transmittance. This cam gives curve shapes independent of concentration within the limits of Beer's Law, permits chemicals to be assigned curve shape index numbers, and therefore permits identifications to be made rapidly from a large number of standard curves.[3] This cam is included in the cam assembly shown in Fig. 4 and may be shifted into place in five seconds. This cam is also available over a limited range of transmittances to give a five-fold vertical magnification.

A fourth modification is a wavelength drive[5, 6] shown in Fig. 24, which permits the instrument to select various ranges and magnify them. Curves of the three possible violet dyes shown in Fig. 6 are obtained with a magnified range.

A fifth modification is a readily positioned wavelength calibration "filter"[7] shown in Fig. 9. A small segment of this must be run as an internal standard to get the wavelength accuracy needed for

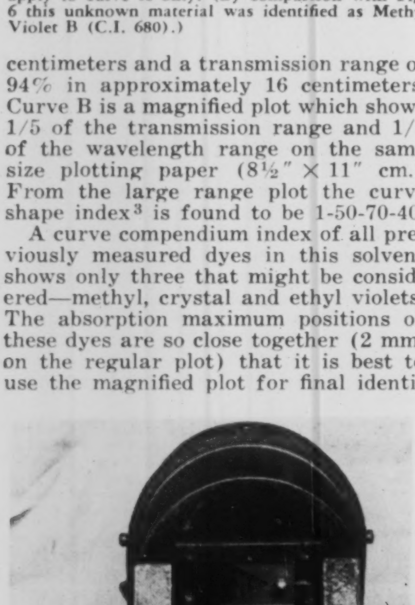

Fig. 8. Optical Stop. (Used to reduce the cross-sectional area of the light beam at the micro-transmission cell. This operates by varying the height of the slit as the V-shaped stop is moved laterally.)

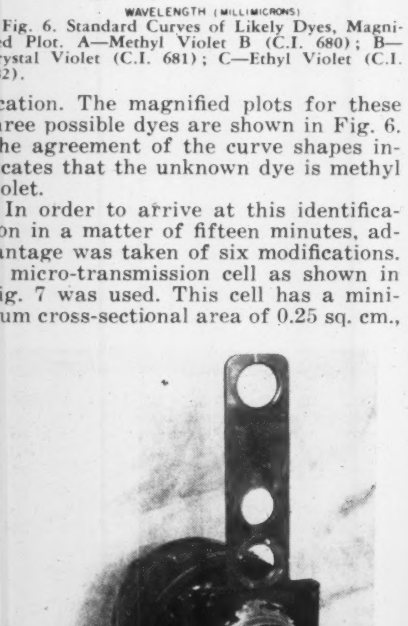

Fig. 9. Wavelength Calibration Retardation Plate. (Upper opening is finger hole, middle opening is hole for light to pass through in ordinary measurements, bottom opening contains quartz retardation plate which is easily pulled up into proper position in the light beam for wavelength calibration.)

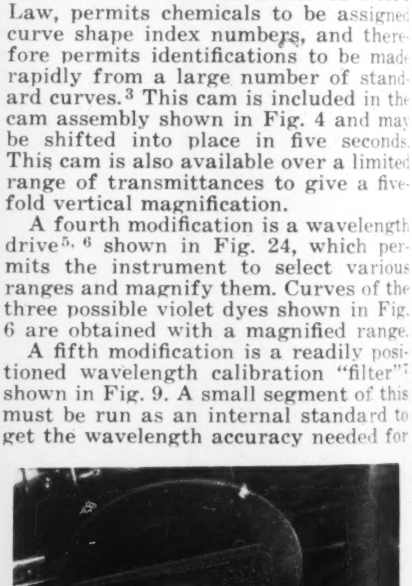

Fig. 10. Wavelength Drive Clutch. (The wavelength motor, which drives the belt, turns a collar which is fastened to the cam shaft by a clutch.)

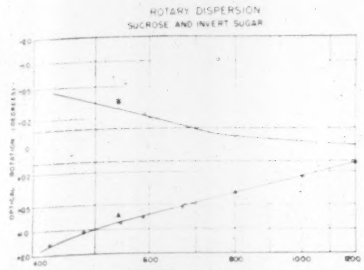

Fig. 11. Rotatary Dispersion Curves. A—Sucrose, 11 grams/liter in 10 cm. cell; B—Invert sugar formed by hydrolysis of the sucrose of curve A. (Points are data from the International Critical Tables.)

this identification. Without the internal standard, paper positioning and paper shrinkage errors may throw off the accuracy unless excessive time is taken to obtain the plots.

A sixth modification is a wavelength clutch, shown in Fig. 10, which permits the abscissa to be turned quickly to the wavelength region of interest in order to run partial curves.

Determination of Reaction Rate of a Chemical Reaction

As an example of the determination of the order of a reaction and its velocity constant, the following reaction may be considered:

$$C_{12}H_{22}O_{11} + H_2O \longrightarrow C_6H_{12}O_6 + C_6H_{12}O_6$$

The initial sugar, sucrose, is dextrorotatary and the final invert sugar, a mixture of dextrose and levulose, is levo-rotatary. This is shown by the rotatary dispersion curves of Fig. 11. This rotatary dispersion curve was obtained with the aid of two modifications. One is a special solution cell shown in Fig. 12 which fits between the photometering rochon and the wollaston. It is 10 centimeters long and holds 45 cc, which means that $45/\alpha$ grams of optically active material must be put in solution to get a rotation of 1 degree. (α is the specific rotation.) The second modification is a cam[8] which plots logarithm of optical rotation and is one of those in the cam assembly of Fig. 4. Since the log function cannot be plotted through zero, the cam is made linear from +0.15° to −0.15°, any such convenient small in the ordinate between the horizontal dotted lines is on a linear basis, different from the remainder of the ordinate.

The inversion may be followed with the spectrophotometer. A suitable wavelength is chosen by examination of the data of Fig. 11. The spectrophotometer is adjusted to this wavelength and the recording drum turned round and round with time. Fig. 13 shows three curves A, B and C, obtained with three successive rotations of the recording drum. Thus, they are actually all the same curve, B being a continuation of A, while C is a continuation of B, but when the paper is taken off the cylindrical recording drum the plot appears as three curves.

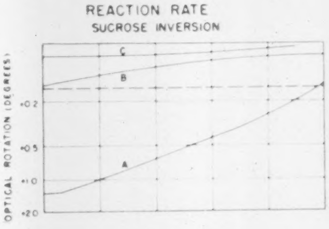

Fig. 13. Change in Optical Rotation with Time. A—Initial drum rotation; B—Second drum rotation; C—Final drum rotation. (All data taken at 450 mu for sucrose at 75°C. in the presence of acid. Total elapsed time 24 minutes. Data above dotted line plotted on linear basis.)

Interpretation of the data of Fig. 13 requires an initial observation of the curve in the logarithmic section (below the dotted line) to determine if it is a straight line. (The initial horizontal segment may be disregarded since it was obtained before the hydrolysis catalyst (acid) was added.) It is a straight line and is a plot of something proportional to logarithm of concentration versus time; the reaction is therefore a first order one.

After it is decided that the reaction is of the first order, the velocity constant may be determined by placing the plot (Fig. 13 on transparent paper) on the nomograph of Fig. 14. When this is done, the slope of the curve of Fig. 13, read from the nomograph of Fig. 14, is divided by the time required to plot a standard interval, and this quotient is the velocity constant in reciprocal time units. For the data of Fig. 13 the velocity constant was found to be $0.21/1 = 0.21$ reciprocal minutes. It is convenient to have different speeds of time drive for reactions of different rates.

In order to do this, advantage was taken of an additional modification. The recorder drum has been altered so that it may be turned with time, leaving the wavelength constant. This mechanism is shown in Fig. 15. It has a choice of gears so that the drum can be turned one revolution in any one of six time intervals from 20 seconds (fastest) to 73 minutes (slowest).

Determination of Refractive Index and Absorption Coefficient of an Ink

Although printing ink films are not homogeneous, some comparisons of refractive index and absorption coefficients of the layer of ink immediately adjacent to a glass surface are of interest in connection with such visual effects as bronzing. A printing ink consisting of 1 part pigment and 1 part 00 lithographic varnish is put on two glass prisms, one a right-angle prism shown in Fig. 16 and the other a Dove prism shown in Fig. 17. Both prisms are arranged to pass undeviated light passing along the paths shown in Fig. 18. When the prisms are placed in the transmission chamber of the instrument, oriented by the positioning blocks

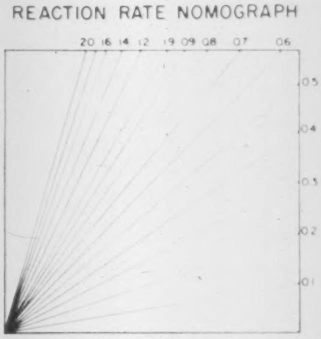

Fig. 14. Velocity Constant Nomograph.

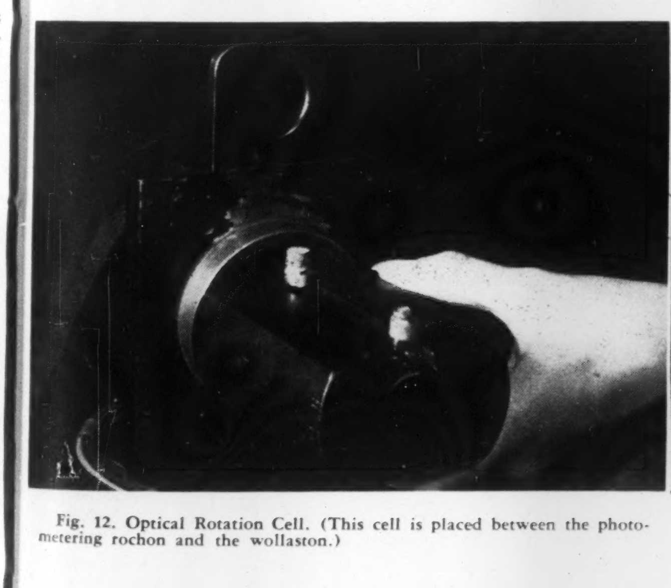

Fig. 12. Optical Rotation Cell. (This cell is placed between the photometering rochon and the wollaston.)

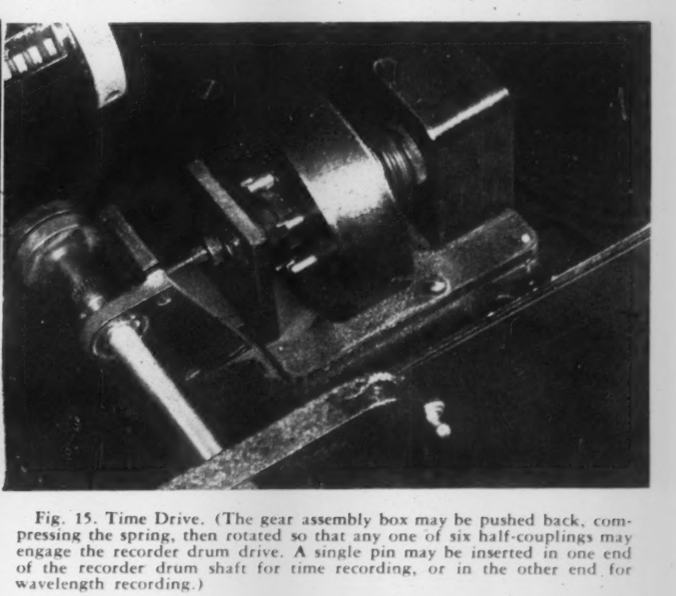

Fig. 15. Time Drive. (The gear assembly box may be pushed back, compressing the spring, then rotated so that any one of six half-couplings may engage the recorder drum drive. A single pin may be inserted in one end of the recorder drum shaft for time recording, or in the other end for wavelength recording.)

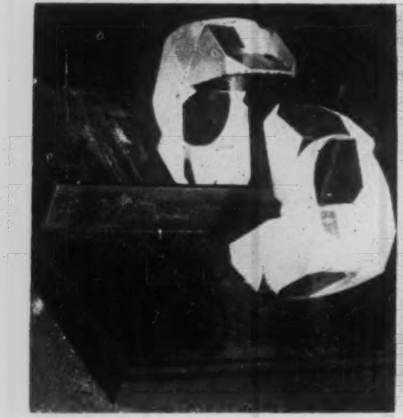

Fig. 16. Right Angle Prisms. (Ink is placed on the hypotenuse of one prism and the specular reflectance at 45° incidence from the glass-ink interface is thereby measured.)

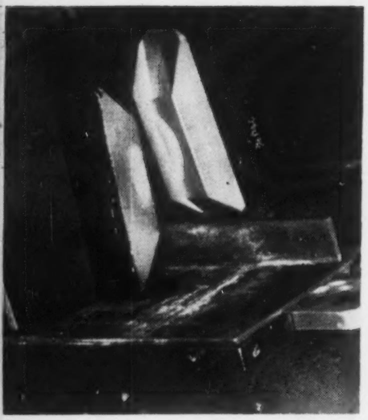

Fig. 17. Dove Prisms. (Ink is placed on the long face of one prism and the specular reflectance at 72.5° incidence from the glass-ink interface is thereby measured.)

shown in Figs. 16 and 17, the light is photometered after reflection at angles of 45° and 72.5°. These reflectance curves are shown in Fig. 19. At 450 mu the reflectances at 45° and 72.5° are 0.2% and 18.0% respectively.

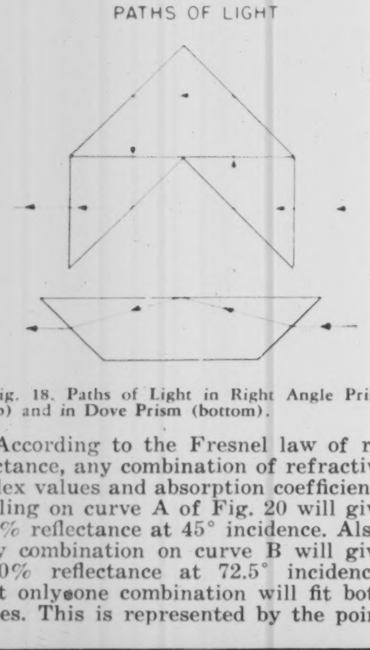

Fig. 18. Paths of Light in Right Angle Prism (top) and in Dove Prism (bottom).

According to the Fresnel law of reflectance, any combination of refractive index values and absorption coefficients falling on curve A of Fig. 20 will give 0.2% reflectance at 45° incidence. Also, any combination on curve B will give 18.0% reflectance at 72.5° incidence. But only one combination will fit both cases. This is represented by the point where the curves of Fig. 20 intersect. Therefore the refractive index and absorption coefficient may be calculated at each wavelength in this way. The resulting curves are shown in Fig. 21.

In order to determine these values advantage was taken of two modifications. One is the non-deviating oblique incidence reflectance holders shown in Figs. 16 and 17. Another modification is a retardation plate flicker system[9] which rotates a retardation plate at 900 rpm between the wollaston and a fixed rochon as shown in Fig. 22. The stationary retardation plate shown in Fig. 22 was removed to give the data of Fig. 19. This is necessary in order to get a fixed state of polarization to simplify calculation of reflection in accordance with the Fresnel theory.

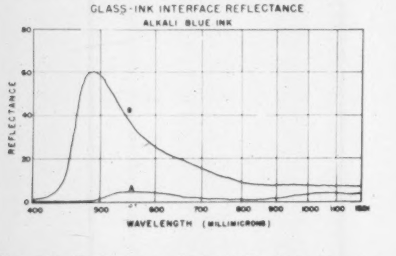

Fig. 19. Reflectance from Glass-Ink Interface. (Alkali Blue, C.I. 704, plus lithographic varnish, 1:1. Electric vector of light perdendicular to plane of incidence.) A—45° incidence; B—72.5° incidence.

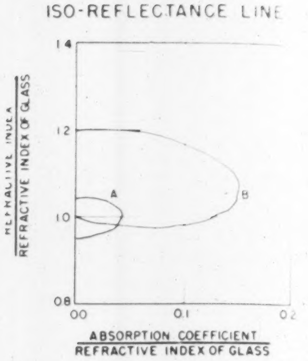

Fig. 20. Iso-Reflectance Lines for Glass Interface. (Electric vector perpendicular to plane of incidence.) A—45° incidence, 0.2% reflectance; B—72.5° incidence, 18.0% reflectance.

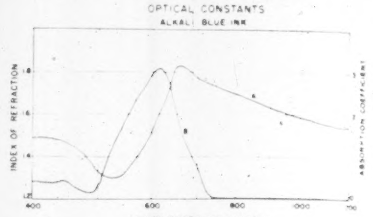

Fig. 21. Optical Constants of Ink Adjacent to Glass Surface. A—Refractive Index; B—Absorption Coefficient, value K in equation $T = e^{-4\pi Kd}$ where T = transmittance; e = base of natural logarithms; π = 3.1416; K = absorption coefficient; d = thickness of the material (cm.); λ = wavelength in air of light (cm.).

Chemical Analysis by Transmittance

As an example of chemical analysis by transmittance, consider the problem of determining the percentage of alcohol in rye whiskey. A five centimeter solution cell is filled with the whiskey

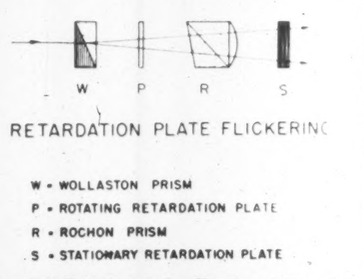
W
P
R
S
RETARDATION PLATE FLICKERING
W - WOLLASTON PRISM
P - ROTATING RETARDATION PLATE
R - ROCHON PRISM
S - STATIONARY RETARDATION PLATE

Fig. 22. Diagrammatic Sketch of Retardation Plate Flickering System.

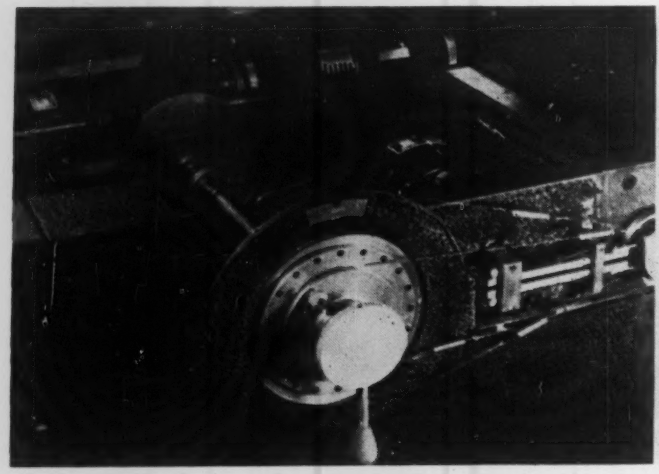

Fig. 24. Recording Drum Drive. (This permits a selection of spectral range plotted and a magnification of 5 to 1.)

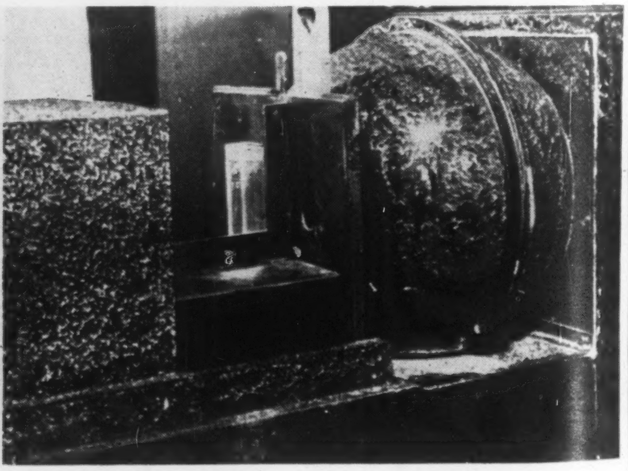

Fig. 25. Transmission Chamber. (Shown here is the sliding cover, the adjustable shelf, and the filter holder for absorbing calibration filters.)

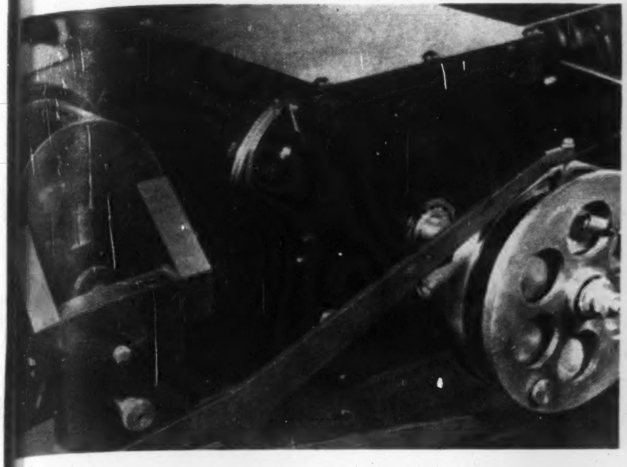

Fig. 26. Epicyclic Gear Reduction Drive. (This performs a 40-1 reduction in angular rotation and transmits the motion of the balance motor to the recording pen without backlash. Also shown are the exit slit and the ordinate-cam assembly housing.)

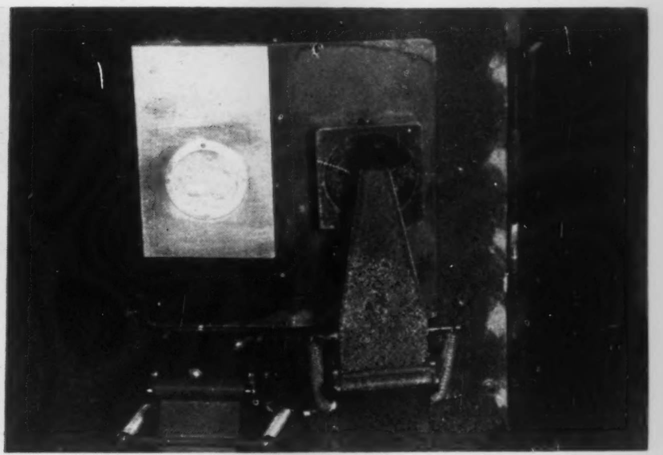

Fig. 27. Sample Holder to Measure "Body Color" of Pastes and Reject Surface Reflectance.

and the transmittance curve run over the range including 1000 mu. Standard curves should be run of pure alcohol and water in the same cell. Fig. 23 presents these three curves. A logarithmic scale is placed on the plot at 960 mu and is found to read 44, 104 and 144 respectively for water, whiskey and alcohol. The percentage alcohol is then calculated as:

$$\frac{144 - 104}{144 - 44} = 40\% \text{ or } 80 \text{ proof}$$

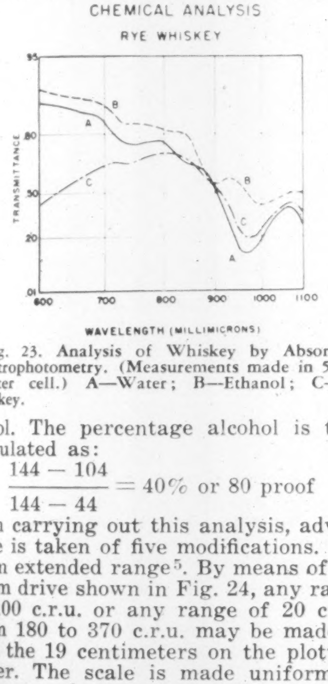

Fig. 23. Analysis of Whiskey by Absorption Spectrophotometry. (Measurements made in 5 centimeter cell.) A—Water; B—Ethanol; C—Rye whiskey.

In carrying out this analysis, advantage is taken of five modifications. One is an extended range[5]. By means of the drum drive shown in Fig. 24, any range of 100 c.r.u. or any range of 20 c.r.u. from 180 to 370 c.r.u. may be made to plot the 19 centimeters on the plotting paper. The scale is made uniform so that several segments may be combined and give a uniform abscissa scale. In this particular case the range shown is one which includes the absorption maximum of interest.

Another modification is the use of a cam[4] for plotting the ordinate as log log 1/T. This was previously discussed in connection with chemical identification. It is useful here in order to compute the amount of one component in a two-component mixture quickly.

A third modification is a sliding cover on the transmission chamber shown in Fig. 25. This is convenient and time-saving.

The fourth and fifth modifications in this series are the cam shifter (Fig. 4) and the abscissa clutch (Fig. 10) previously described.

Incidentally, for more precision in chemical analyses, a cam is used which magnifies the normal log log 1/T plot five times, the plotting speed is slowed down (the belt shown in Fig. 10 is driven with a thyratron-controlled motor), and advantage is taken of a drive[10] from the balancing motor to the pen with no backlash, shown in Fig. 4 and 26.

Determination of Crystal Structure

The pigment chrome yellow is lead chromate, chemically speaking, and can exist in two crystalline modifications, monoclinic and orthorhombic. These crystalline forms differ in visual appearance, the orthorhombic having a shorter dominant wavelength. Commercial samples of the "green" shade type tend to turn "redder" with age, a phenomenon attributed to the unstable orthorhombic form's changing to the stable monoclinic form. Measurements of "color stability" are a measure of the relative proportion of these two crystal forms in a sample.

Samples of chrome yellow are mixed with lithographic varnish in a ratio of 1:1 by mulling to make an ink which is placed on a sample holder shown in Fig. 27. This sample holder is a piece of glass with curved surfaces mounted in a metal sheet. The glass faces are parallel and have a radius of curvature of 25.4 centimeters. The sample holder is mounted with the concave side facing the integrating sphere and the ink is placed on the convex side. Surface light is reflected out of the sphere through the same window by which the light enters, as shown diagrammatically in Fig. 28.

Two pins on the metal part of the holder fit into two holes on the back of the spectrophotometer to facilitate positioning. This sample holder permits measurements of inks with normal illumination and integrated viewing, and still rejects the specular component. (For measurement of flat samples with elimination of specular reflection, a black mask[11] symmetrical about the entrance window, is inserted in the sphere, as shown in Fig. 29, thus maintaining normal incidence, diffuse reflecting conditions.)

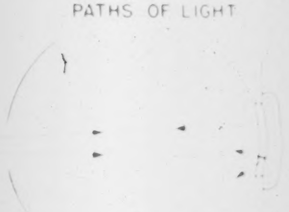

Fig. 28. Schematic Diagram of Light Striking Paste-Sample Holder. (Upper light path indicates rejected surface reflectance. Lower light path indicates measured "body" reflectance.)

The spectrophotometric curves of monoclinic, orthorhombic, and a 50-50

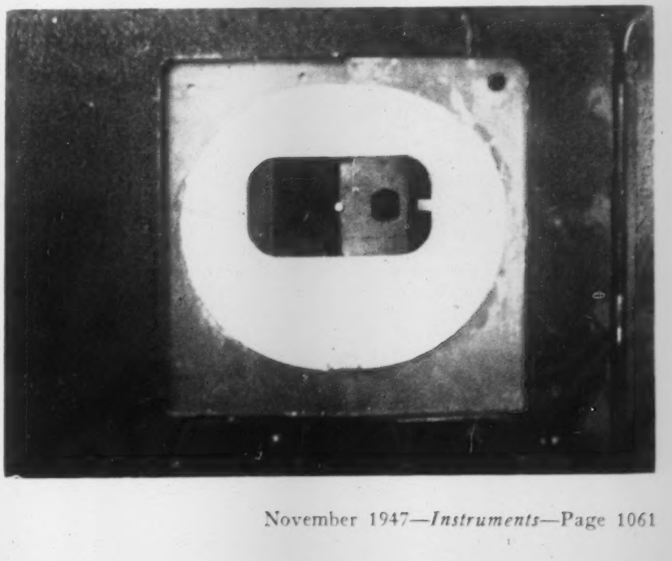

Fig. 29. Black Mask to Absorb Specular Light. (Portion of integrating sphere is removed to show interior. Part of photocell is also visible.)

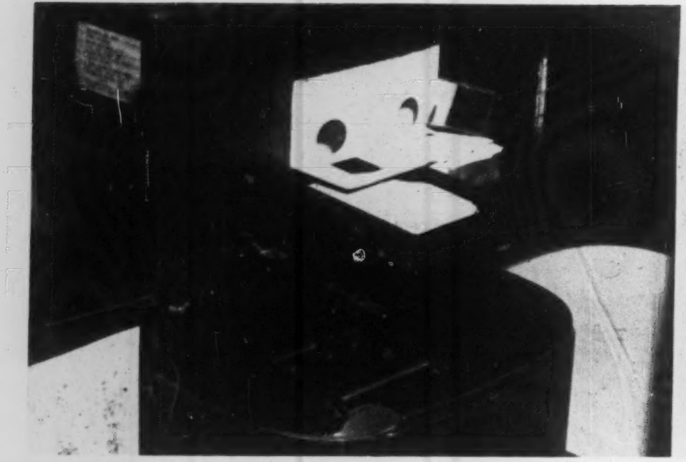
Fig. 31a. Horizontal Reflectance Sample Holder. (Prisms out of place.)

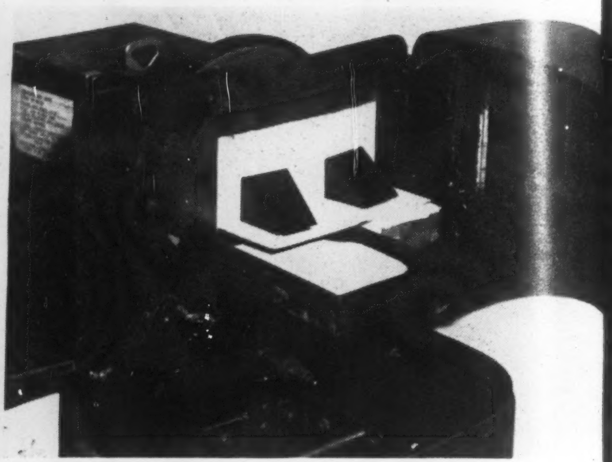
Fig. 31b. Horizontal Reflectance Sample Holder. (Prisms in place f measuring reflectance from a tray filled with betanaphthol flakes.)

mix lead chromate are shown in Fig. 30. With the aid of these reference curves, samples of commercial chrome yellow pigments may be analyzed for crystallographic properties.

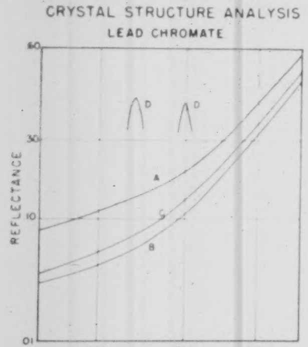

Fig. 30. Analysis for Crystal Structure. (Inks of chrome yellow measured in sample holder shown in Fig. 27.) A—Orthorhombic chrome yellow; B—Monoclinic chrome yellow; C—Mixture of 50/50 orthorhombic and monoclinic chrome yellows; D—Calibration filter.

Advantage is taken of three modifications in this analysis. One is the special sample holder described above and in Fig. 27; another is the cam[2] which plots log $(1-R)^2/R$, which permits slight vertical shifting of the curves for comparison of curve shape. The third is the abscissa magnifying cam[5,6] which permits smaller changes in composition to be analyzed.

Colorimetry

Betanaphthol may be a flaky product containing some powder, and its quality is sometimes judged visually by opening a drum of it and looking at the exposed top surface in the drum. High quality correlates with whiteness.

The whiteness cannot be measured by viewing a vertical surface, which could be obtained by filling a glass cell and looking at its side, because in this method of viewing the powder portions are more evident and the flakes are not arranged predominantly perpendicular to the incident light as in the practical case of interest. Consequently the material is viewed with a special sample holder shown in Fig. 31. (This sample holder was useful in wartime testing of the reflectance of drift indicators. For these tests various materials were floated or suspended in water and measured with vertical illumination.)

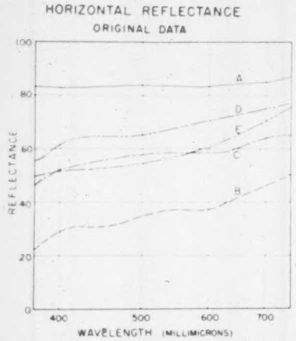

Fig. 32. Original Data (Traced) of Betanaphthol Measurement. A—Magnesium carbonate; B—Standard paper, low reflectance; C—Standard paper, high reflectance; D—Good quality betanaphthol; E—Poor quality betanaphthol.

Fig. 32 shows both good and poor quality betanaphthol flakes as measured. Special calibration standards, such as magnesium carborate and white blotting paper, must be used since the sample holder does not exactly reproduce normal integrated viewing conditions.

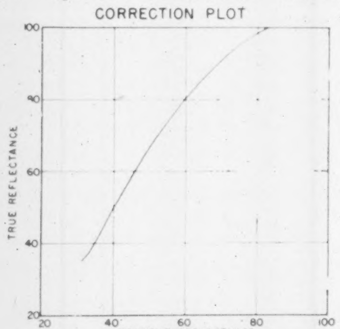

Fig. 33. Correction Plot for Horizontal Reflectance Data. (This curve has been found empirically to be independent of wavelength.)

A calibration chart such as that of Fig. 33 must be used to put the data on an absolute basis such as that in Fig. 34, but absolute data may not be necessary in plant control problems.

Advantage is taken of two modifications here, one of which is the horizontal sample holder pictured in Fig. 31. The other is a retardation plate[12] placed in the optical system between the last polarizing element and the sample. This plate eliminates any ill effects due to the partial polarization of light reflected from a mirror at an angle. It is the stationary retardati plate of Fig. 22.

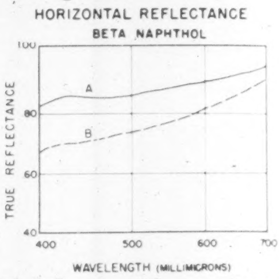

Fig. 34. Reflectance of Betanaphthol Flakes. A—Good quality betanaphthol; B—Poor quality be naphthol.

Summary

Twenty-three modifications of t automatic recording spectrophotomete have been described. These are (1) a rotating skein holder, (2) a cam t plot the function log [(1—R) 2R where R = reflectance, (3) a magnifie wavelength plot, (4) a magnified fun tion of transmission plot, (5) a micr transmission sample holder, (6) a optical stop in the monochromato (7) a cam to plot log log 1/T whe T = transmission, (8) a calibrati filter positioning device, (9) a wav length clutch, (10) an optical rotati sample holder, (11) a cam to plot log where α = angle of optical rotatio (12) a cam assembly permitting quic selection of cams, (13) a recorder-drum time device, (14) oblique incidence sam ple holders, (15) retardation-plate flick ering in the photometer, (16) an ex tended wave length range, (17) a slid ing cover for the transmission chambe (18) variable plotting speeds, (19) a pen drive free from backlash, (20) a sample holder rejecting the specula component, (21) a horizontal sampl holder, (22) retardation plate polarization-mixing of the photometering light and (23) a black mask for absorbing specular reflectance of flat samples.

Seven illustrative examples have been discussed where these modifications are helpful in problems of (1) chemical analysis of reactions on fibers (2) chemical identification in solution (3) determination of reaction rates (4) determination of refractive index and absorption coefficient of inks, (5) chemical analysis by transmission (6) measurement of crystal structure and (7) the colorimetry of chemicals.

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[10]O. W. Pineo, U. S. Patent 2,358,097 (1944).

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Section News

(*Continued from Page 1056*)

tended the October 6th meeting at Phil Smidt's in Roby, Indiana to hear Dr. Donald J. Bergman, Chief Engineer of Universal Oil Products Company, present "A New Technique in Oil Refinery Instrumentation—the Fluid Cat Cracker." His talk included a description of the process and some very interesting data on the instrumentation of a typical unit.

Dr. Bergman first explained the difference between thermal and catalytic cracking units, and described the characteristics of the catalyst, then, with the aid of slides and a small air-operated glass model of a cat-cracker, he demonstrated the action of the reactor and regenerator, and showed the flow of catalyst through the unit. Stating that the instrumentation of such a unit cost approximately 5½ per cent of the capital investment (exclusive of piping and installation) he then discussed the various types of instruments required to maintain the catalyst level, pressure balance and heat balance of the system.

The talk was well received and evoked dozens of questions during the discussion period which followed.

The November 3rd meeting of the Chicago Section was announced as a talk on "Radiosondes" by V. D. Hauck, Chief Engineer of the Friez Instrument Division of Bendix Aviation Corp. The December 8th meeting will feature Chicago's own J. B. McMahon, of Republic Flowmeters Co., who will present a revised version of his well-known "Non-Mathematical Discussion of Flow Metering."

—SYLVA MAE DUSHKES, *Corr.*

CINCINNATI

The November meeting of the Cincinnati Section is scheduled for the 24th at 8 P.M. in the Engineering Society Building. The Speaker is Mr. Roy J. Teetsell of Westinghouse Electric and Manufacturing Company, who will speak on "Electrical Measuring Instruments."

—R. F. ROMELL, *Corr.*

CLEVELAND

The first meeting of the 1947-48 season held on September 24th featured a most interesting and informative talk by Mr. C. H. Barnard of Bailey Meter Company, who discussed the use of electronic assemblies for the measurement and control of a vast variety of quantities and conditions. The speaker stressed the simplicity of application of electronic equipment to otherwise difficult and complicated problems.

The meeting was very well attended and the question period indicated a lively interest in the subject. Our thanks to Mr. Barnard for a very informative talk.

On October 22nd we are to be addressed by Dr. Willard N. Greer of the Leeds and Northrup Company on the subject of "Industrial pH Measurement and Control." Dr. Greer has been associated with Leeds & Northrup for some twenty years, serving in the research and market development departments, and has contributed much to the development of pH measurements in gas analysis, electrolytic conductivity and reduction potentials. A Westinghouse short educational film is also scheduled for this meeting. —L. H. WALDRIP, *Corr.*

CUMBERLAND

The Cumberland Section held its regular September meeting at the Queen City Hotel on Tuesday, September 23, 1947, with dinner at 6:30 P. M. followed by the meeting at 8:00 P. M.

Harry Stern of the Hercules Powder Company, President of the Cumberland Section, was the delegate to the Second Annual Instrument Conference and Exhibit in Chicago in September; he was the speaker of the evening, assisted by Robert Wilson of the Kelly-Springfield Tire Company, who accompanied Mr. Stern to the Conference. Mr. Stern spoke on the electronic equipment while Mr. Wilson explained the mechanical side.

On Friday, September 26, 1947, the Cumberland Section made a field trip to the Gulf Research & Development Company in Pittsburgh. Mr. Paul Exline and Mr. Harry Bowman did an excellent job of conducting the tour through the laboratories. The trip was very interesting and all concerned had a very enjoyable day.

This section is sponsoring a course in elementary physics as related to instrumentation. For quite some time, the members have expressed a desire for such a course and it will become available during the month of October.

Our program for the October meeting is not complete at this time.

—G. WILLIAM HARRISON, *Corr.*

DETROIT

The September 16th meeting of the Detroit Section featured Mr. W. F. Swann of Eastman Kodak Company on "The Role of Photography in Industry," and Mr. R. R. Proctor of the Pure Oil Company Research and Development Laboratories who discussed "An Electronic Spark Advance Indicator." The month's demonstration featured equipment of The Scientific Instrument Company of Detroit.

Mr. Swann's talk outlined the many and varied applications of photography in industrial organizations, ranging from the microfilming of drawings and records to the photographic layouts used in building large bombers. One particular use of the camera mentioned was in measuring the amount of pulpwood carried on flat cars by photographing the ends of the standard length logs. His lecture was illustrated by slides and was followed by a short film demonstrating the uses of Eastman's high speed 16-mm. movie camera which gives magnifications of time as high as 200 to 1.

Mr. Proctor's discussion of the electronic road test panel (spark advance indicator and tachometer) used in the borderline method of rating automotive fuels, featured slides showing the basic circuit developments and the elementary principles of operation of the instrument. He also explained the means developed to overcome the difficulties found in earlier models. His description of the electronic principles involved in the functioning of the instrument was exceptionally clear and understandable. A working model of the instrument, as well as the device used for calibrating and checking it, was shown after the meeting through the courtesy of the Ethyl Corporation.

The display of control and measurement equipment provided by the Scientific Instrument Company consisted of very attractive display panels showing working models of their products.

In a short business meeting prior to the technical session, President Raviolo announced the appointment of J. W. Head as Secretary of the Detroit Section, replacing Secretary-elect R. W. Gardner who resigned for personal reasons. H. H. Barnum, National Vice-President, presented a short report on the Chicago Conference and Exhibit.

The October 21st meeting will feature Mr. Wesley S. Erwin, Research Laboratories Division of General Motors Corporation, speaking on "The Automatic Sonigage"; and Mr. Edwin E. Puls, Cities Service Oil Co., who will discuss "The Industrial Heat Prover."

The November meeting will bring to Detroit Mr. Harry F. Moore of Standard Oil Development Company, who will discuss "Organization of the Instrument Department." W. E. WILSON, *Corr.*

EASTERN NEW YORK

The first meeting, after the summer lull, got off to an excellent start on Tuesday, October 4, with a Smoker at the Circle Inn in Lathams Corners, New York, and with Dr. E. D. Haller of the National Technical Laboratories as our speaker. His subject was "Hydrogen Ion Concentration."

After reports to the members by the President, Secretary and Delegate on the activities at the Chicago Conference, Dr. Haller took over and proceeded to give a very interesting talk, well illustrated by slides, on the ins and outs of pH measurement. After the talk was over, the floor was opened for questions and the rate at which they came showed that there was extreme interest in the subject.

When this period was over, all present retired to nearby tables which were well stocked with beer and sandwiches, and a lively informal discussion followed.

Much interest was shown in the exhibit of rare old instruments obtained through the efforts of the Education Committee and sponsored by the General Electric Company.

Our next meeting is on November 4, at Siena College. The program will feature "Discussions of Selected Subjects" by Eastern New York Section members. This meeting is also the nominating meeting for new officers for the coming season.

—W. J. CLAFFIE, *Corr.*

NEW JERSEY

The New Jersey Section held its first meeting of the new winter series at the Essex House, Newark, on October 7th. The turnout was good. The multitude of familiar faces seen, plus several new ones, indicated that the general interest in the subject of Instrumentation continues to thrive in New Jersey.

Our speaker for the evening was Charles E. Cunningham of the Selas Corporation of America, manufacturers of furnaces and combustion equipment designed for extremely high heat release values.

The speaker chose for his subject, "Instrumentation of High Heat Release Furnaces." A rather unique situation developed as the speaker described the design of the equipment. It was soon apparent to most of his audience that this covered equipment utilizing gaseous fuel which, insofar as concentration of heat and time factor were concerned, was comparable to induction heating produced by alternating current.

Our speaker challenged his audience to suggest methods for "instrumentizing" his process to reduce the time lag between the temperature measuring means and the final control element so that the overall response of the control system would be reduced to fractions of a second. A very lively discussion of this point came from the floor, with the net result that most everyone realized that the millenium has not yet been reached in the design of control systems.

Plans are progressing to exhibit, at each of our forthcoming scheduled meetings, some of the newer equipment designs in instruments currently being offered to the trade. It is anticipated that this will produce additional interest from the membership. —H. M. MCCARTHY, *Corr.*

NEW YORK

The fifty-first meeting of the New York Section was held at the West Side Y. M. C. A. on Wednesday, September 24th, 1947. About 35 members and guests were present.

Section President H. L. Hildenbrand opened the meeting at 8 o'clock. Additional members were appointed to serve on the membership committee. An amendment to the Section By-Laws eliminating the initiation fee after October was announced and scheduled for a vote at the October meeting. Professor Kayan and Ralph Batcher then gave short reports on the Second Annual Instrument Conference held in Chicago.

Mr. Noel C. Jamison, of Philips Laboratories, Inc., was then introduced by President Hildenbrand. Mr. Jamison presented a talk on "The Measurement of Radiant Heat by Means of Bolometers." Various types and their ranges and sensitivities were discussed. Slides were used to show typical performance curves, and the blackboard was freely used to explain the mathematical background. —CHARLES D. COREY, *Corr.*

NIAGARA FRONTIER

The Niagara Frontier Section opened its fall sessions with an outstandingly successful meeting at Hayes Hall on the campus of the University of Buffalo on Friday evening, October 3, at 8 P. M.

The Student Engineering Society of the University acted as host to the Section, and the speaker was Mr. Gerald F. Akins of Eastman Kodak Company, who presented his widely renowned talk "Demonstration of Automatic Control Principles." The speaker was introduced by Mr. Richard Rimbach, Executive Secretary of the I.S.A., who very ably conducted the meeting as Master of Ceremonies.

The 450 people in attendance enthusiastically received the excellent presentation and demonstrated by Mr. Akins, who was assisted by Mr. John Kowalski.

The local A.S.M.E. chapter responded to the invitation to attend with an excellent turnout.

The newly organized Niagara Frontier Section is rapidly developing in membership and activities. The members and visitors at the meeting, including representatives of local industrial management, were pleased to receive Mr. Rimbach's comments of approbation and his statements concerning the aims and achievements of I.S.A.

The next meeting will be held at the New York State Institute of Applied Arts and Sciences on Monday, October 27, 1947, with Mr. Fred Trapnell of E. I. duPont de-Nemours & Company as the speaker.

—RUSSELL MILHAM, *Corr.*

NORTHERN INDIANA

Members of the Northern Indiana Section have started a busy season by participating in four meetings so far this fall. First was the Second Annual Instrument Conference and Exhibit in Chicago, in which several members were actively engaged in committee functions and which most members attended at some time or other.

Followed then a business meeting on September 23 in East Chicago, Ind. This meeting was called primarily for the purpose of nominating a slate of officers for the coming season. Several reports were heard concerning the Chicago Conference, and considerable discussion ensued on ways and means of increasing the membership of the Section and providing the type of program the members desire at each of the technical meetings during the coming season.

Then on October 6th, the Northern Indiana and Chicago Sections seld a joint meeting at Phil Smidt's in Roby, Ind., at which Dr. D. J. Bergman, Chief Engineer of Universal Oil Products Company of Chicago spoke on the instrumentation of the Fluid Cat-Cracker.

The first regular technical meeting of the Northern Indiana Section was held in the Gary Y.M.C.A. on the evening of October 15th. Following the cafeteria style dinner, Mr. G. M. Stafford of the Taylor Instrument Company spoke on the new developments Taylor has made recently in their line of instruments. Included in the talk were discussions and explanations of the Transet, the pitot-venturi primary measuring element, the diaphragm-type liquid level transmitter, the Taylor electric contact controller, and the electro-pneumatic interrupter.

The new officers for this year were regularly installed following the mail ballot on nominations made at the September 23rd meeting. These officers are as follows:

President: Edward L. White, Standard Oil Co.
Vice-President: Kenney Frame, Standard Oil Co.
Treasurer: Thomas R. Stafford.
Secretary and Delegate: C. P. Haynes, Red River Oil Refinery Co.
Publicity Chairman: J. Baum Beckman.

Because of an earlier misunderstanding, the Northern Indiana Section was a bit late in electing officers and the new boys will have quite a job ahead of them getting started, but if the enthusiastic spirit is any indication, a prosperous season can be expected.

—ED. L. WHITE and J. BAUM BECKMAN

OAK RIDGE

The October 1st meeting was held at Central Cafeteria in Oak Ridge, the meeting being called to order by our new President Chas. W. Covey, who presented to the Section the new officers for the coming season, as follows:

President: Chas. W. Covey.
Vice-President: B. B. Bell.
Secretary: J. O. Alexander.
Treasurer: A. K. Johnson.
Executive Counselor: A. H. Fowler.

Following a rather lengthy business session, the meeting was turned over to Program Chairman N. L. "Tiny" Isenhour, who introduced the "first" speaker of the evening, Mr. J. R. Tallackson of the Oak Ridge Monsanto Chemical Company. Mr. Tallackson's talk was entitled "The Automatic Recording Spectrophotometer."

The talk began with a discussion of the fundamental units of a spectrophotometer. The light source, reflection and beam-splitting, photo-electric circuits, amplifiers, differentiating apparatus and such were discussed. The instrument was distinguished from other spectrum instruments, and the recording and measuring unit, as well as the correcting device used to consider varying wave lengths and light intensity, were discussed in detail.

Mr. Tallackson's talk was well illustrated by a number of large color posters drawn by the speaker especially for the occasion. At the conclusion of the talk a question and answer session held forth for quite a period.

As intimated above, Mr. Hallackson was to have been the first speaker, and it was originally intended that he should be followed by A. H. "Andy" Fowler, Carbide & Carbon Chemical Corp., speaking on "Engineering Statistics." However, because of the long business session, time did not permit Andy's talk. Needless to say, we are looking forward with keen interest to a future meeting when his talk will be presented.

—J. O. ALEXANDER, *Sec'y.*

PHILADELPHIA

The first meeting of the fall sèason, held on September 17, was greeted by an unusually large attendance of Philadelphians anxious to renew old acquaintances, discuss their instrument troubles once more with sympathetic listeners, and to exchange notes on the Chicago Conference.

In announcing the coming elections, President George Ehly stressed the importance of the coming year and the need for serious consideration in the nominations for offices and committee workers. Ed Grace was introduced at this point to present his message regarding the mammoth job in store for the Philadelphia Section during the coming year. Plans for the 1948 Philadelphia Instrument Fair are well along, he reported, with the appointments of the Papers Committee, Short Course Committee, Finance Committee and Planning Committee. Each has already reported organization plans, and all have begun to get feelers out for their respective responsibilities.

Doc. White, delegate, then briefly recapitulated the proceedings of the Chicago meeting of the Board of Directors, announced the names of the newly elected national officers, and discussed the action taken by each of the Society's committees.

Joe Voytilla, Instrument Consultant for E. I. duPont deNemours & Co., was introduced as the principal speaker. Joe did an exceptional job of bringing the Chicago Instrument Exhibit to those who were unable to attend. He described in detail those exhibits which he had had time to visit, pointing up the features or applications which had particular appeal. He also described the instrument installations, practices and applications observed on the inspection trip through the Whiting, Indiana, refinery of Standard Oil Company.

Next, Joe very capably reviewed two of the papers presented in the technical sessions, one being an intensely interesting presentation of dew point measurement apparatus and the other a very graphic demonstration of pneumatic controller components and their function.

Unstinting appreciation to the National Society and to the Chicago Section for a thoroughly interesting Conference and a well organized Exhibit was voiced by Joe in his final remarks.

The next meeting, scheduled for October 15th, brings what promises to be a paper of lively interest on the subject of electronic controls as applied to the aircraft industry, presented by Mr. Gordon Volkenant of Minneapolis-Honeywell Regulator Compan.

—J. JOHNSTON, JR., *Acting Corr.*

ST. LOUIS

The first regular meeting of the St. Louis Section for the 1947-48 season was held on Tuesday, September 30, 1947, at the Engineers Club in St. Louis. Although dinner was arranged for those who desired it, the practice of holding a dinner meeting as carried out last year was not followed. This was in the nature of an experiment, to determine the response of the membrship to a diffrent type of meeting. The response was gratifying with 85 attending ing the dinner earlier. It is planned to continue this method of meeting in the future, and meetings will be held at the Engineers Club on the first Tuesday of each month at 8 p.m.

No October meeting was scheduled, the next meeting being on Tuesday, November 4. The speaker at this meeting is to be Mr. William Myers of the Alco Valve Company, who will speak on "Automatic Control of Refrigerator Systems."

The speaker on September 30 was the Rev. James B. McElwane, S.J., A.M., M.S.; Ph.D., Dean of the Institute of Geophysical Technology at St. Louis University, who spoke on The Role of Instrumentation in Geophysics." Rev. MacElwane described the development of instruments used for detecting disturbances in the earth, from the first crude instruments to the present sensitive and refined equipment. The basic principle of the seismograph was explained, consisting of the use of a damped pendulum, moving in a horizontal or a vertical direction, and carrying a pen which records on a moving drum. By the use of three pendulums the movements of the earth may be ressolved into East-West, North-South and vertical components, from which the direction and extent of the movement can be computed.

Rev. MacElwane presented a number of excellent slides showing the instruments and their construction, and explained the operation. The talk was well presented and interesting, and was followed by numerous questions.

—H. E. ZEFF[illegible]EN, *Corr.*

SOUTHERN MICHIGAN

The Southern Michigan Section held its first meeting of the year at Chicken Charlie's on September 24th. President Olive Woods called the meeting to order, and after round-the-table introductions, conducted a short business meeting. Visitor H. H. Barnum, National Vice-President, spoke briefly concerning the scheduling of meetings, following which Program Chairman Wade Allen introduced the speaker of the evening, Dr. W. F. Enz of the Upjohn Company.

Dr. Enz presented a very interesting talk on "Instruments and Equipment Used in Production of Potable and Process Water." The talk was introduced by a table showing an analysis of Kalamazoo's water, which is relatively hard. Various exchange materials were described, and considerable attention was given to deionizing softeners, in which instrumentation plays an important part. He concluded with a description of the easily-transported and completely automatic compression still, which is used to produce relatively pure water from sea water.

The second meeting of the season was held on October 8th. After presentation of the National Charter by Past President Wade Allen, the speaker of the evening was introduced — Mr. Paul Freeman of Electronic Industries, Inc., Indianapolis, Ind. His subject was "Fundamentals and Applications of Semi-Conducting Rectifiers."

These rectifiers were described as being fundamentally composed of two dissimilar metals which pass current in one direction more easily than in the other—like a leaky check valve in a hydraulic system. The various characteristics of copper oxide, selenium, and copper sulphide recitfiers were then discussed in considerable detail.

—R. J. SCHOFIELD, *Corr.*

TENNESSEE

The Tennessee Section held its regular (but delayed) September meeting at the Kingsport Inn on Wednesday, October 1. Following dinner at 7:00 p.m., a short business meeting was called to order by President F. H. Theile and the minutes of the previous meeting were read by Secretary L. W. Thayer. J. T. Elder, National Delegate, reviewed the Second National Instrument Conference and Exhibit held in Chicago and which he and Mr. A. W. Bri attended.

George Moorehouse of the Tennessee Eastman Corporation spoke briefly on the application and operation of the valve positioner.

The guest speaker of the evening was M Bruce Irwin of Hammel-Dahl Co. The subject of Mr. Irwin's talk was "Control Valves and Control Valve Characteristics." The talk was well illustrated by slides and was very interesting. At the conclusion of the talk Mr. Irwin answered informal questions from the floor. The meeting was adjourned at 10 o'clock.

The next meeting of the Section will be held on Wednesday, October 29. Dinner will be at 6:45 p.m. at the Sherwood Restaurant, followed by the meeting at 8 o'clock in the Kingsport Civic Auditorium. "Special Safety Instruments" is the subject of the talk to be presented by Mr. F. R. Davis, Sr., of the Davis Emergency Equipment Company.

—L. W. THAYER, *Sec'y.*

TWIN CITIES

The first meeting of the season was held on Tuesday evening, September 30, and was attended by 36 members. The meeting was held in the Coffman Memorial Union at the University of Minnesota, starting with dinner at 6:45.

The speaker of the evening was Dr. R. B. Vaile, Jr., of the Armour Research Foundation in Chicago. Dr. Vaile is assistant chairman of physics research, and his subject for the evening was 'The Problems Involved in Magnetic Recording for Instrumentation Compared with Those for High Fidelity Sound." The talk covered the problems involved in developing either a wire or tape recording and playback machine, and the characteristics of the various recording media in use in these machines today.

—R. E. HOPPE, *Corr.*

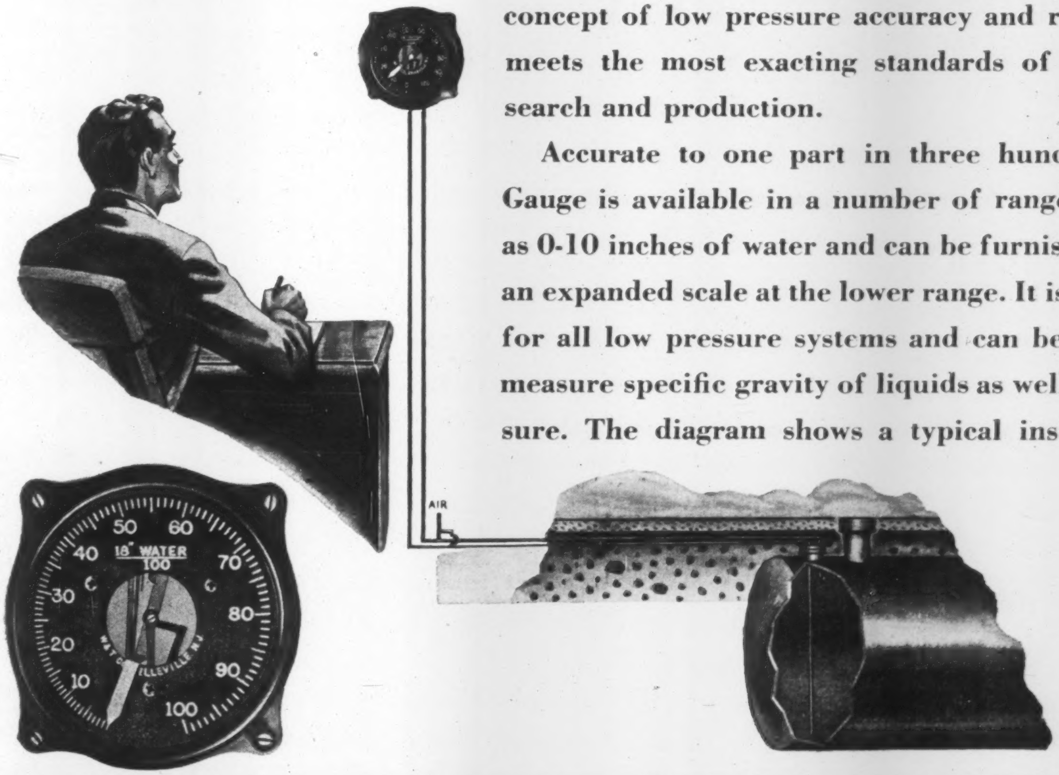
(*ISA JOURNAL continued on p. 1068*)

There's no need to "stick" the tank with Wallace & Tiernan Low Pressure Gauges

In today's manufacturing processes, so many liquids and gases are handled at high pressure that low pressures are often neglected. Yet the accurate measurement of very low pressures is perhaps more essential than ever and as always presents unusual problems.

The mere fact that pressures are low means that normally allowable errors of measurement are prohibitive. That's why the W & T Low Pressure Gauge offering a new concept of low pressure accuracy and reliability meets the most exacting standards of both research and production.

Accurate to one part in three hundred, the Gauge is available in a number of ranges as low as 0-10 inches of water and can be furnished with an expanded scale at the lower range. It is suitable for all low pressure systems and can be used to measure specific gravity of liquids as well as pressure. The diagram shows a typical installation.



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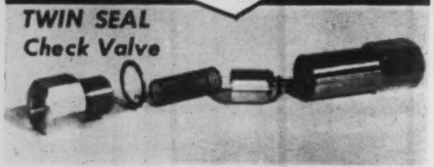

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Custom Built Hand Pumps
may be an adaptation of the general purpose pump illustrated, or special pumps fabricated entirely of bar stock parts machined from alloys to meet specific conditions.

—Write for Bulletin—

MANSFIELD & GREEN
1051 Power Avenue CLEVELAND 14, O.

Simplified Warm Hardness Test

(Concluded from Page 1006)

pered to a point where it gives inaccurate room temperature readings. If so, it must be discarded. (After running ten complete tests, however, the ball indenter used continued to give accurate readings. It is probable that the short time of contact between ball and heated sample is insufficient to produce undesirable tempering.)

2. Wear gloves at all times while handling the warm assembly.
3. Speed is essential in taking readings and placing and removing the assembly in the testing machine in order to minimize temperature rise during testing and heating up of the machine.
4. Always make indentations on the sample in the immediate vicinity of where the "Tempilstik" powder fused.
5. Observe all normal precautions used in hardness testing.

The following limitations of the test should be noted:

1. The test is limited to a moderate temperature range.
2. Formation of a slight temper film on the testing surface may affect readings.
3. Since a finite time is required to make two or three readings, the readings may cover a range of as much as 10°F. If greater accuracy is desired, the average of three readings may be assumed to represent the hardness 5°F. above the temperature of "Tempilstik" fusion.
4. Use of a relatively cool indenter on a warm specimen may affect readings.

Despite the simplicity of the test and absence of such refinements as protective atmosphere, potentiometer temperature control, etc., the readings provide such smooth hardness vs. temperature curves (see Fig. 2) that the method is considered adequate for all but precise laboratory work.

Experience has shown that the test to 600°F. requires about 40 minutes including set-up time. One hour is required to test to 650°F. and one and one-half hours to 700°F. Better heating units would considerably reduce these time requirements.

Samples of hardness tests run to date are shown in curve form in Fig. 2. The resistance to softening of SAE 3335 and SAE 3110 steels may be attributed to their nickel contents. In fact, the initial softening of three points Rockwell "B" might be due to errors introduced by factors mentioned above. The nickel-free hubbing steels used to obtain the lower two curves show an almost linear softening with temperature. It is interesting to note here that hardness readings taken as the specimen cooled slowly were found to fall on the same curve as those during heating.

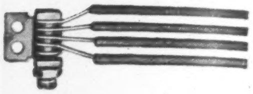
The Rockwell "B" test was chosen in preference to other tests for the following reasons:

1. The small indentation produced permits making many indentations on a small testing area.
2. It provides a rapid, direct reading.
3. The small indenter introduces the least error due to differential heat effects.

Although this method provides only a low or "warm" temperature test for ferrous materials, it is suggested that it might prove of greater value in some non-ferrous investigations where 700°F. represents a temperature not too far below the melting point.

BRADLEY
COPPER OXIDE RECTIFIERS

IMPROVE INSTRUMENTS AT LOW COST



Vacuum-processed, gold-coated Bradley instrument rectifiers increase equipment efficiency. Especially designed for use where stability and permanence of calibration are important, "Coprox" rectifiers meet the most exacting requirements. Yet they cost no more than ordinary rectifiers — in most cases, less.

Temperature error is exceptionally low with Bradley rectifiers. Aging is practically nil. Pre-soldered leads. Rating of CX-2E series up to 4.5 volts A. C., 3 volts and 5 milliamperes D. C.

Illustrated literature, available on request, shows more models of copper oxide rectifiers, plus a line of selenium rectifiers and photocells. Write for "The Bradley Line."

BRADLEY LABORATORIES, INC.
82 Meadow St. New Haven 10, Conn.

Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from the nufacturers. We urge readers to request ONLY those bulletins which will be of value to em. Use the Postage-free Order Card on page 1069.

O-528 **Dust Counting. 2-page** 8½″ × ″ bulletin pictures and describes makr's "Dust-Vue Microprojector" designed r use in determining numerical concenations of impinger and precipitator ust samples by projecting with a magfication of 100 ×. Mine Safety Applinces Co., Braddock, Thomas and Meade ts., Pittsburgh 8, Pa.

O-529 **Surface Combustion Recorder.** 2-age 8½″ × 11″ bulletin describes makr's "Dew Point Recorder" which proides a virtually continuous record of umidity within a temperature range of -40°F. to room temperature. Special nits for recording to 80°F. Surface Comustion Corp., Toledo, O.

O-530 **Cold Zone Tester.** 6¼″ × 3½″ rochure features maker's "Fifty-Fifty" old zone tester with combined accuracy f instrument, bulb and lead, ±2% of full ale, (±2°F). J-B-T Instruments, Inc., hapel St., New Haven 8, Conn.

O-531 **Circuit Switches,** 8½″ × 11″ heet diagrams RSA-50 and RSA-60 witches for band and tone control ciruit switching in radio receivers and ther electronic applications where medum and low torque indexing action is esired. P. R. Mallory & Co., Inc., Indanapolis 6, Ind.

O-532 **Resonant Relays.** 2-page 8½″ × 1″ Catalog No. 116A pictures and deribes maker's line of relays for remote ontrol by radio or carrier current hrough frequency discrimination. Steens-Arnold Co., 22 Elkins St., S. Boston, Mass.

O-533 **Small-Lathe Chuck.** 4-page 8½ × 11″ Bulletin No. 947 illustrates and escribes "University Bordjaw Chuck No. ″ for repeating lathe operations with xact concentricity and parallelism. pecifications are included. Edward lake Co., 634 Commonwealth Ave., Newon Centre 59, Mass.

O-534 **Phase Rotation Indicator.** 2-page ½″ × 11″ loose-leaf describes and picures "Model 32A" for indicating phase equence 50 to 600 volt, 25 to 120 cycles , 2 or 6 phase, giving salient features nd their applications. H. H. Sell Co., 907 Willow Ave., N., Minneapolis 11, inn.

O-535 **Night Visibility Meter.** 2-page 9″ × 12″ folder describes "Hunter" night isibility meter for measuring the night isibility of traffic paints and signs. Heny A. Gardner Laboratory, Inc. 4723 Elm t., Bethesda 14, Md.

O-536 **"Sound Advances."** 4-page 8½″ × 11″ technical bulletin describes appliation and construction of maker's "Impedance Vectorgraph" for recording utomatically the impedance component s a function of frequency. Sound Aparatus Co., 233 Broadway, N. Y. 7, N. Y.

O-537 **High-Pressure Switch.** 8½″ × 1″ loose-leaf sheet pictures and decribes maker's "Hi-Pressure" switch or the control of high pressure hydraulic air and steam systems. Diaphlex, Div. Cook Electric Co., Chicago 14, Ill.

O-538 **Industrial Control Instrument.** 8½″ × 11″ 2-page loose-leaf illustrates and explains the "Shadowmaster," which consists of a miniature type photoelectronic amplifier, housed in twin cast aluminum cases. The Autotron Co., Danville, Ill.

O-539 **Smoke Indicator.** 2-page 8½″ × 11″ Bulletin 580-C explains and diagrams the maker's instrument for measuring smoke density. Ess Instrument Co., Bergenfield, N. J.

O-540 **Electronic Control Circuit Tube.** 4-page 8½″ × 11″ Bulletin 73-3A pictures, diagrams and explains the "Chronotron" tube developed for use in electronic-control circuits. Eclipse-Pioneer Division, Teterboro, N. J.

O-541 **Lead Checker.** 8½″ × 11″ sheet 647-2M pictures and describes the "1204 Sine-Line" which checks leads from 6″ to a spur gear, using sine-bar principle to compensate for various leads. Michigan Tool Co., 7171 E. McNichols Rd., Detoit 12, Mich.

O-542 **Flammable Vapor Detector.** 2-page 8½″ × 11″ Bulletin 33R2 pictures and describes maker's "Thermalo" for continuous sampling of atmosphere. Jabez Burns & Sons Inc. 11th Ave., & 43rd St., N. Y.

O-543 **Differential Pressure Indicator.** 1-page 8½″ × 11″ Bulletin 181-1 illustrates and describes maker's "Model 181" built to supplement "Model 163." Barton Instrument Co., 3500 Union Pacific A., Los Angeles 23, Calif.

O-544 **Temperature Controller & Indicator.** 1-page bulletin describes "Series 500," designed for use with electric furnaces, ovens, melting pots, heating tanks and other heating devices. Thermo Electric Mfg. Co., 480 W. Locust St., Dubuque, Iowa.

O-545 **Industrial Flowmeter.** 4-page 8½ × 11″ Bulletin No. 905 illustrates maker's "Type 8" flowmeter for measurement of liquid and gas flows in engineering tests and production processes; and describes performance, design, operation, maintenance and variety of applications. Commercial Research Laboratories, Inc., 20 Bartlett Ave., Detroit 3, Mich.

O-546 **Photomicrographic Camera.** 2-page 8½″ × 10″ Catalog No. 8905 illusscribes the "Microflex" camera which employs mirror reflex principle of focusing. Gamma Instrument Co., Inc., 95 Madison Ave., New York 16, N. Y.

O-547 **Air-operated Controllers.** 40-page 8½″ × 11″ Catalog No. 8905 illustrates and describes control instruments for temperature, pressure, flow, liquid

(Continued on Page 1069)

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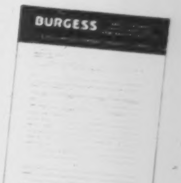

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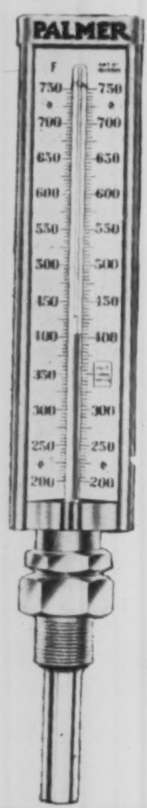

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Who's Who in the I.S.A.

H. L. HILDENBRAND

(Delegate, New York Section)

Although it is possible that the subject of this article, Mr. H. L. Hildenbrand, of Bayside, Long Island, New York, may no longer be President and Delegate of the New York Section of the I.S.A. by the time this is in print, he fills those offices at the time of this writing and, since he has been so active in the affairs of the Society, it is felt that he is deserving of this publicity, even at this late date.

H. L. was born and raised in Onarga, Illinois, some two-score plus years ago, and we take up the thread of his life history from the day in 1925 when he received his B.S. degree in Electrical Engineering from the University of Illinois. Immediately after his graduation he spent some time on the *Westinghouse Student Course*, and then went on the staff of *The Electric Journal* as Assistant Editor. In 1927 he became Engineering Editor of *Electrical Record* (Gage Publishing Co., New York). Shortly thereafter Gage Publishing Company started *Electrical Manufacturing*, with H. L. Hildenbrand as Engineering Editor. In 1929 he became Managing Editor of *Electrical Manufacturing.*

Later that same year he returned to Westinghouse to become Assistant Editor of *The Electric Journal*, and in 1930 was made Circulation Manager.

In 1933, chiefly as a result of some Westinghouse economies, H. L. joined the Esterline-Angus group and in 1934 became their representative in Pittsburgh. In 1939 he went to New York City as their representative, and has been there since.

He attended the initial meeting of the group which later formed the New York Society for Measurement and Control (and still later became the New York Section of the I.S.A.) and served as Secretary for two years, Executive Committee member for one year, Vice-President for one year, and the major portion of this year as President and Delegate. These duties will cease, he says, sometime late in November when he leaves to make his home in Onarga, Illinois again. His business plans are nebulous at this writing, but there is not much doubt that some of the Sections of I.S.A. near Onarga will be enjoying his presence at their meetings occasionally before long.

HOMER C. GIVENS

(Delegate, South Texas Section)

The tall Texan who represents the Sout Texas Section of the I.S.A. on the Board o Directors is really an Iowan by birth—bor near Iowa Falls i January, 1907. Hi Southern accent doe come from environment, however, becaus he moved with his parents when he was thre years old to Beav County in the Oklahoma panhandle. Living on the cattle ranc run by his parents, h attended and graduate from Forgan Hig School (1925) as valedictorian of his class. He entered Oklanom A & M College in the fall of 1925 and obtained his B.S. in Mechanical Engineerin in 1929. Immediately thereafter he went t work for Shell Petroleum Corporation in th natural gas—gasoline division. While wit Shell he did a great amount of work on th control of the operation of multi-colum fractionation units. A few patents on controllers were issued to Shell in which Home had a considerable "hand" in developing.

After leaving Shell in 1937, Homer became Measurement and Control Enginee for the Gasoline Plant Construction Company, building the first natural gasolin plant in South Texas near Corpus Christ. Shortly afterward, however, he joined Gul Oil Corporation as Mechanical Engineer i the natural gas—gasoline department, wher his duties were mostly modernizing thei process control.

In 1939 he went to Grand Rapids, Michigan, where he supervised and engineere the construction of a gasoline plant for th Pent-Hex Corporation. In 1940 he becam Measurement and Control Engineer for th Gasoline Plant Construction Company, building cycling plants in Texas. He joined a newly-formed company in Corpus Christ, The LaGloria Corporation, in 1941, and has been with them since. At present he is Assistant Superintendent, as well as Measurement and Control Engineer, of the cyclin plant—one of the largest gas-distillate cycling plants in the United States. He has charge of all production and disposal o products, as well as maintenance of al measurement and control equipment.

In October, 1945, Homer helped organiz the South Texas Instrument Society, which became the South Texas Section of the I.S.A on January 1, 1947. He has held the offic of Secretary of the Section since is beginning, and has served as Delegate sinc early this year.

Homer is married and has two daughters 14 and 10 years old. He has one very practical hobby—collecting, of all things, slide rules and mechanical pencils! Perhaps he's trying to make engineers out of those tw daughters of his!

Employment Department crowded out of this issue of the *JOURNAL;* but the next issue will be mailed *early* in December.

level and humidity. The Brown Instrument Co., Wayne and Roberts Avenues, Phila. 44, Pa.

O-548 **Recorder-controller.** 8-page 8½" × 11" Bulletin C 2-1 presents design and specification data for the "Capocilog" strip-chart recorder for indication, control and permanent record of variables in the process industries. Wheelco Instruments Co., 847 W. Harrison St., Chicago 7, Ill.

O-549 **Ring-measuring Instrument.** 8½" × 10½" loose-leaf sheet pictures and describes maker's "Ring Mike" for accurate piston-ring measurement with both fractional and decimal readings. Circle Gauge Co., 5145 York Blvd., Los Angeles 42, Calif.

O-550 **Voltage-dividing Rheostat.** 12-page 8½" × 11" Bulletin 104 covers rheostat in which unusually long precision-wound slide wire is helically coiled within a small compact case; pictures and describes special features and automatic equipment for linearity. The Helipot Corp., 1011 Mission St., S. Pasadena 8, Calif.

O-551 **Two-lens Quartz Spectrograph.** 8-page 8½" × 11" Bulletin 151-74 describes and illustrates the principal features of precision research instrument, including dispersion curves for interchangeable quartz and glass optics; specifications, etc. The Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.

O-552 **High-voltage Resistors.** 4-page 8½" × 11" Bulletin G-1, Catalog Section G, gives complete specifications and characteristics of "Type MV" designed for high-voltage applications where high resistance and power are required. International Resistance Co., 401 Broad St., Philadelphia 8, Pa.

O-553 **Service Testing Machine.** 4-page 8½" × 11" Bulletin 260 pictures and describes maker's line of fatigue and simulated testing machines, including the "R. R. Moore," "SF-10-R" rotating beam types, "Universal Models SF-01-U, SF-1-U, SF-20-U, SF-4," etc. The Baldwin Locomotive Works, Philadelphia 42, Pa.

O-554 **Pneumatic Gages.** 20-page 8½" × 11" booklet features maker's new line of "New-Matic" measuring machines which incorporate two improvements, "point-to-point" gaging and "balanced air." Five models are illustrated. Merz Engineering Co., 200 S. Harding St., Indianapolis 7, Ind.

O-555 **Laboratory Test Equipment.** 4-page 8½" × 11" bulletin of technical information includes a table showing impedance vs. decibel loss, with values calculated for impedance mismatch, minimum "T" loss and bridging pad loss, plus data with diagrams on mixer circuits. The Daven Co., 191 Central Ave., Newark, N. J.

O-556 **Pneumatic Transmission.** 12-page 8½" × 11" Bulletin 98156 pictures and describes maker's system which con-

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